Compaq StorageWorks

RAID Array 3000 Controller Shelf

Hardware User's Guide

EK–SMCPQ–UG. C01

Compaq Computer Corporation
Houston, Texas

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Revision Record

This Revision Record provides a concise publication history of this guide. It lists the revision levels, release dates, and reasons for the revisions.

The following revision history lists all revisions of this publication and their effective dates. The publication part number is included in the Revision Level column, with the last entry denoting the latest revision. This publication supports the StorageWorks RAID Array 3000 Controller Shelf.

Revision Level	Date	Summary of Changes
EK–SMCPQ–UG. A01	May 1998	Original release.
EK–SMCPQ–UG. B01	July 1998	Adds RETMA cabinet shelf support installation procedures.
EK–SMCPQ–UG. C01	July 1999	Adds Shelf-to-Host connection diagrams to Chapter 1 and dual controller configuration procedure to Chapter 4.

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About This Guide

This section identifies the audience of this guide and describes the contents (chapter-by-chapter) and structure. In addition, this section includes a list of associated documents and the conventions used in this guide.

Intended Audience

This guide is intended for installers and operators of the RAID Array 3000 Controller Shelf. Installing the shelf requires a general understanding of basic SCSI terminology and product installation procedures.

Document Structure

This guide contains the following chapters:

Chapter 1: Product Overview

Product Overview provides an overview and a physical hardware description of the RAID Array 3000 controller shelf. It includes the major features, a brief description of the major components, a series of controller shelf-to-host connection diagrams, and the specifications for the shelf.

Chapter 2: RAID Array Controller

RAID Array Controller describes the major features and characteristics of the controller in the RAID Array 3000. It also lists the RAID levels supported by the subsystem and a brief description of each level. Redundant operation and environmental considerations (i.e. backup power management, voltages, and temperature) are covered at the end of the chapter.

Chapter 3: Installation and Maintenance

Installation and Maintenance recommends how to install the controller and device expansion shelves in a rackmount RETMA or metric cabinet. The information covers both single and multiple device expansion shelf installations. The chapter also describes how to interpret the status and power LEDs on the front panel, how to replace a Field Replaceable Unit (FRU), and how to add or replace a SIMM module in the RAID controller.

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Chapter 4: Second Controller Option

Second Controller Option describes how to install a second (redundant) RAID controller in the shelf for redundancy. It also contains a dual controller installation procedure for a single serial port.

Associated Documents

In addition to this guide, refer to the following documentation to properly install and setup your specific subsystem configuration:

Table 1 Associated Documents

Document Title	Order Number
StorageWorks RAID Array 3000 Configuration and Maintenance Guide	*EK–SMCS2–UG*
7 Device, 16-Bit SBB Shelf (BA356-S Series) User's Guide	*EK-BA356-UG*
StorageWorks SBB Shelf I/O Modules User's Guide	*EK-SBBIO-UG*
RAID Array 3000 Getting Started for Windows NT-Intel Installation Guide	*AA-RACZA-TE*
RAID Array 3000 Getting Started for Windows NT-Alpha Installation Guide	*AA-RACUA-TE*
RAID Array 3000 Storage Subsystem Second Controller Option Installation Guide	*EK-SM3KC-IG*
Command Console 2.1 for RAID Array 3000, User's Guide	*AA-RBF2B-TE*
RETMA Shelf Rail Kit Installation Guide	*EK-35XRB-IG*
RETMA Bracket Installation Guide	*ER-PCBAR-AA*

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Conventions

This guide uses the following documentation conventions:

Table 2 Style Conventions

Style	Meaning
plain monospace type	Text
boldface type	For the first instance of terms being defined in text, or both.
italic type	*For emphasis, manual titles, chapter summaries, keyboard key names.*

Table 3 Nomenclature Convention

RAID Advisory Board Description	RAID Array 3000 Usage
RAID 0	**STRIPset**
RAID 1	**MIRRORset**
RAID 0+1	**STRIPED MIRRORset**
RAID 4	**STRIPED with a Fixed parity drive**
RAID 5	**STRIPED with a Floating parity drive**

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Multivendor Customer Service (MCS):	
Installation	Contact the Compaq Customer Support Center (CSC).
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1

Product Overview

This chapter provides an overall description of the RAID Array 3000 Controller Shelf and its components. A series of cabling diagrams showing how to connect the Controller Shelf to a host system and a list of technical and environmental specifications is also included at the end of the chapter.

NOTE

This guide is the Hardware User's Guide. For configuration information, refer to the *Getting Started RAID Array 3000 for Windows NT – Intel Installation Guide* and the *StorageWorks Command Console (SWCC) 2.1 User's Guide*.

1.1 Product Description

The RAID Array 3000 Controller Shelf (Figure 1–1) is a rackmount storage system containing the basic components required to manage a storage array with two 16-bit, differential, UltraSCSI bus host interfaces. The devices, referred to as StorageWorks Building Blocks or SBBs, are disk drives from the StorageWorks family of storage devices. The release note that accompanies the storage system lists the software solutions and disk drives that are supported.

The Controller Shelf is connected to one or multiple (up to four) 6-slot Device Expansion Shelves (shown in Figure 1–2) to form the complete RAID Array 3000 storage system. The expansion shelf is offered as an option with a minimum of one shelf required. It contains six SBB slots for the disk drives, two power supplies, and a personality I/O module that connects the SCSI interface with the controller shelf. The Device Expansion Shelf is supported by its own user's guide (Part No.: *EK–BA356–UG*) which must be used in conjunction with this document to properly install and configure your storage system.

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NOTE

The Device Expansion Shelf (DS-SWXRA-GN) must have a revision level of B01 (or higher) to operate with the RAID Array 3000 Controller Shelf. Also, the Personality I/O module supplied with the shelf (part no. 70-33067-02) must have a minimum revision level of H01 or higher.

The Controller Shelf and the accompanying Device Expansion Shelves are installed in a standard RETMA or metric rackmount cabinet design. The Device Expansion Shelves are typically mounted directly above the Controller Shelf in the cabinet. Each shelf is supplied with a bracket mounting kit to secure the unit into the desired cabinet design. The bracket kit for a metric cabinet is optional and must be ordered separately.

Figure 1–1 RAID Array 3000 Controller Shelf

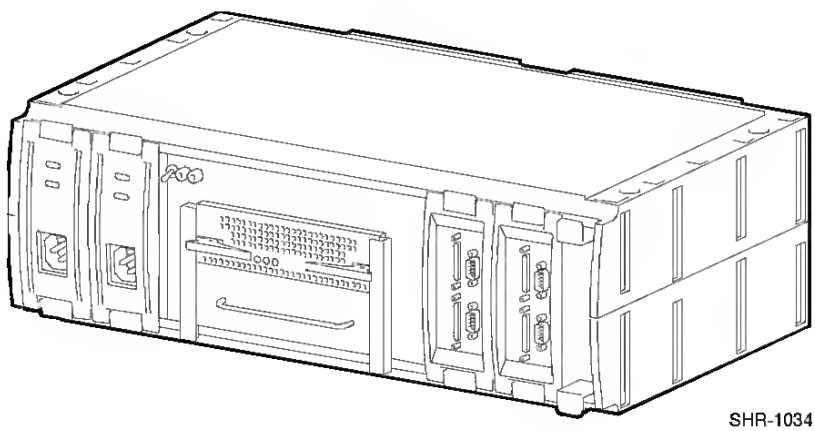

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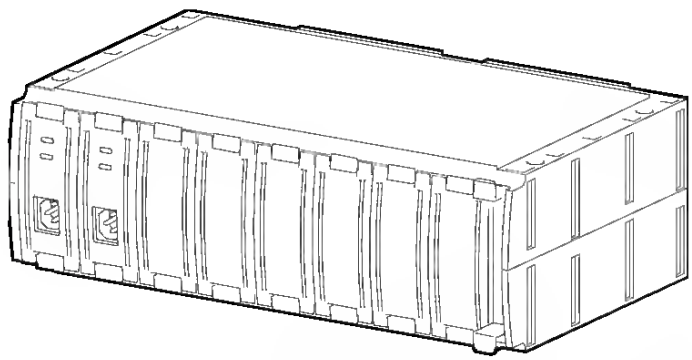
Figure 1–2 RAID Array 3000 6-Slot Device Expansion Shelf (Optional)



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A battery-backup subsystem is included with the Controller Shelf in the form of a rackmount UPS (Uninterruptable Power Supply). In case of a power failure, the UPS provides temporary power to the storage system while it flushes its cache contents to disks. The UPS is normally installed in the lowest available slot in the cabinet.

CAUTION

The UPS is sized to perform this function for the Controller and Device Expansion Shelves only. No other electrical devices should be plugged into the UPS.

As an option, a second RAID controller module can be added for redundancy. The second controller operates in conjunction with the installed controller to protect data in case of a malfunction in the primary unit. The optional controller is installed directly below the primary controller in the center of the shelf.

The RAID Array 3000 Controller Shelf enclosure and its associated options are listed and described in Table 1–1.

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Table 1–1 Controller Shelf Part Numbers and Model Descriptions

DIGITAL Part No.	Item Description
DS-SWXRA-GH	RA3000 UltraSCSI Rackmount Controller/Shelf with one controller, 120 V, which Includes: One BA356 type shelf One HSZ22 RAID controller with 16 MB of cache Two 180 Watt power supply SBBs, two dual-port, differential, Ultra Wide, Host I/O modules One dual-channel, wide, single-ended device I/O module One 1000 Watt UPS with rackmount bracket One five meter host SCSI cable Two 9-pin serial controller cables Two Trilink SCSI cable adapters One gray C13-to-125 V power cord One black C13-to-125 V power cord One Controller Shelf rackmount kit User documentation. Requires: Solutions Software Kit for platform, host adapter, and disks. Options: Second HSZ22-AA controller and cache memory upgrade.
DS-SWXRA-GK	RA3000 UltraSCSI Rackmount Controller/Shelf with one controller, 230 V, which includes: Except for power cord (DS-SWXRA-GK includes one black C13-to-230 V), same as DS-SWXRA-GH above.
DS-SWXRA-GN	RA3000 UltraSCSI Rackmount 6-Slot Storage Expansion Shelf which includes: 16-bit shelf assembly, two 180 Watt power supply SBBs, 16-bit Personality I/O assembly, shelf rack mounting kit, power cords, user documentation.
DS-HSZ22-AA	RA3000 Second Controller Option which includes: DS-HSZ22-AA SCSI controller, three 16-MB SIMM modules, 0.8 m adapter-to-SCSI-3 cable, 5 m SCSI cable, 9-pin serial cable, user documentation

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1.2 Shelf Features

The RAID 3000 Controller Shelf is equipped with a dual-channel RAID controller that supports all of the UltraSCSI bus features.

The major features of the controller shelf are:

- One dual-channel RAID array controller
- Second controller option for redundancy
- Memory cache expansion option for the controller
- Redundant power provided by two universal ac input power supplies (50/60 Hz, 100 to 240 V ac)
- Dual two-speed blowers for shelf cooling
- Cache backup provided by an external Uninterruptable Power Supply (UPS)
- Controls from one-to-four 6-slot Device Expansion Shelves for a total of 24 UltraSCSI devices
- Can be installed in a RETMA or metric style rackmount cabinets

1.3 Controller Shelf Enclosure

The Controller Shelf is housed in an rack-mount enclosure. It has two power supplies, a single RAID Array controller, an empty slot for a second (redundant) controller, two host I/O assemblies, and a dual-bus device I/O assembly. Two blowers located at the back of the enclosure cool the shelf.

An internal backplane assembly connects the RAID controller and the power and host I/O SBBs. The backplane contains five connectors which provide the interface between the Shelf SBBs and the controller. Two 300-pin connectors located in the center of the backplane provide the controller interface. The backplane connection to the blowers is made through two separate 9-pin female connectors, one for each blower.

The backplane also contains a complement of circuit components that provide SCSI bus termination, blower fail/safe circuits, UPS power sense circuit, shelf status and dc power monitoring, and a speaker alarm circuit with an operator controlled alarm disable switch. The outputs of the shelf status and dc power monitoring circuits are connected to two LED indicators on the front panel of the shelf to notify the operator during a malfunction. The alarm disable switch allows the operator to turn off the audible alarm if desired.

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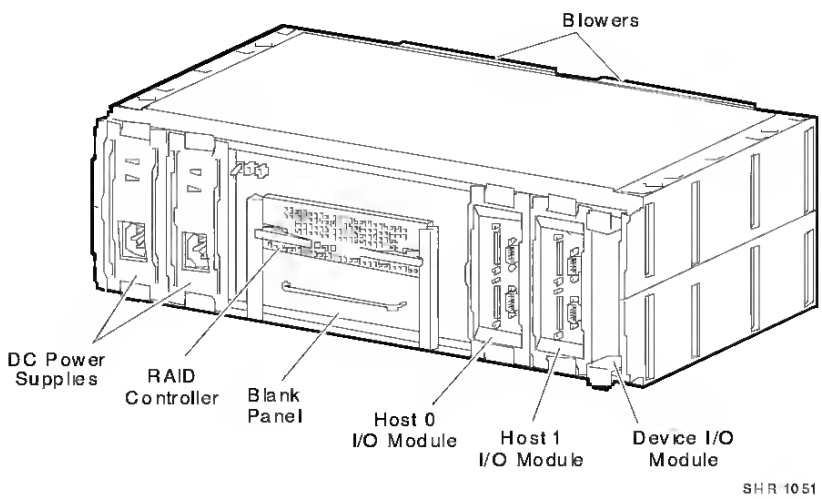
Figure 1–3 shows the major components in the controller shelf. Its characteristics are outlined below.

- An easily removable, two channel, resident RAID Array controller and an adjacent empty slot for a second (redundant) controller (optional)
- There are two 68-pin VHDCI female SCSI connectors on the front panel of the device I/O assembly which interconnect the RAID controller to the SCSI buses in each storage shelf. SCSI connections to multiple Device Expansion Shelves are made using Trilink adapters
- The front of the shelf contains two LEDs that monitor the status of the shelf and the shelf dc power supplies
- The front of the shelf has a toggle switch that allows the operator to disable the shelf alarm during an error condition
- The shelf host I/O assemblies each contain two 68-pin VHDCI female SCSI connectors that interconnect the host systems to the RAID controller
- Each host I/O assembly contain a 9-pin serial port connector (for controller configuration) and a 9-pin UPS monitor connector
- Two dc power supplies (one redundant) that power the shelf components
- The shelf contains two high-speed, plug-in blowers for shelf cooling

Figure 1–3 Controller Shelf Major Components



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1.4 Shelf Cabinet Installation

The Controller Shelf can be mounted in a StorageWorks metric or RETMA style cabinet. You must install the appropriate shelf rail kit hardware to properly mount the shelf in the cabinet. The RETMA rail kit is supplied with the shelf and contains the installation guide which describes the installation procedure. The rail kit for a metric cabinet is optional.

The commercial UPS supplied with the Controller Shelf is installed in the cabinet using a special mounting bracket designed to accommodate either a metric or RETMA style cabinet. The bracket has two sets of mounting holes at each end which allows its installation into either cabinet.

1.5 Shelf Major Components

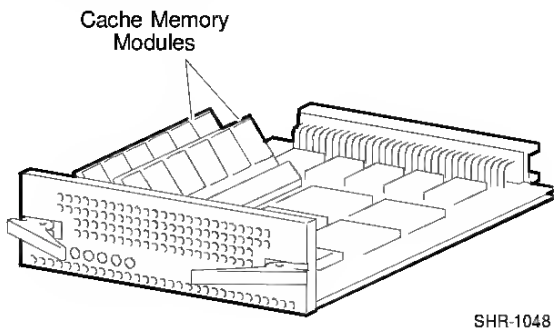
The major components in the controller shelf (see Figure 1–3) include:

- Dual-channel **RAID array controller** (a second redundant controller is optional)
- A 16-bit, **device I/O module** with the SCSI bus isolator/converter circuitry
- Two 16-bit, **host I/O modules** that interface the host(s) to the shelf controller
- Two universal 180 W, 50/60 Hz, 120 or 240 Vac **power supplies**
- Two dual-speed **blowers** to cool shelf components

1.5.1 RAID Array Controller

The RAID controller (Figure 1–4) contains two Wide/UltraSCSI/differential host channels and two Wide/UltraSCSI/Single-Ended disk channels. In dual-controller configurations, the controllers support fully automatic and smooth controller failover in the event of a RAID controller fault.

Figure 1–4 RAID Array 3000 Controller



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The controller supports one (for a single controller) or two (for dual-controllers) standard 72-pin cache SIMMs of up to 64 MB. In a dual-controller setup, both controllers must have identical cache configurations and the total usable cache (per controller) will be half the amount installed due to mirroring. Thus, in a single controller setup the maximum usable cache is 128 MB while a redundant setup has a maximum usable cache of 64 MB (per controller).

The RAID Array 3000 controller contains the following features:

- Single PCB form factor for inclusion in the shelf
- Support for dual hot-swap controller operation
- Dual differential Ultra-Wide SCSI host channels
- Dual single-ended Ultra-Wide SCSI disk channels
- RAID level 0, 1, 0+1, 4, 5, and JBOD support
- Voltage/temperature monitoring and support
- Cluster support for specific operating systems
- 32 Logical Units (LUNs) per host channel (some operating systems may be limited to 8)
- Support for spare disks
- UPS backed write caching
- Per LUN write cache/write back selection
- Configuration/Maintenance via serial or host SCSI channel using (SWCC) StorageWorks Command Console (refer to the operating system platform kit for details).
- Update of firmware via host channel

1.5.2 Device I/O Module

The device I/O module (Figure 1–5) provides the electrical interface between the RAID controller and the device buses. The module resides in the far right slot of the Shelf and has the following features:

- Ability to electrically isolate the controller shelf and the device SCSI buses
- Single channel, single shelf, single-ended bus operation
- Single channel, single-ended bus operation for two Device Expansion Shelves using a Trilink adapter
- External 16-bit data bus connections
- Switch selectable 16-bit, 8-bit, or no SCSI bus termination

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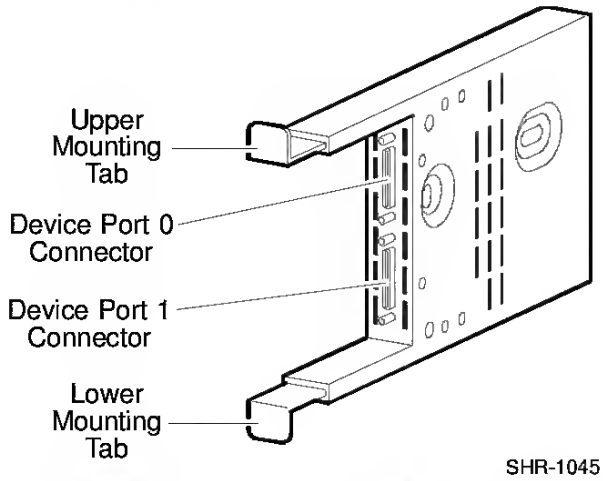
- Two-speed blower operation
- SBB shelf blower control to include error detection, reporting, and automatic corrective action

Figure 1–5 Device I/O Module



The dual-channel device I/O module has two 68-pin VHDCI female connectors mounted on the front panel (see Figure 1–5). The upper connector is the "device port 0" connector. The lower connector is the "device port 1" connector.

The device I/O module top and bottom guides properly align the module in the shelf and with the backplane connector at the back of the shelf. When you install the module the two-spring steel mounting tabs expand and engage the shelf. The combination of the mounting tabs and the backplane connector ensures that the module is firmly seated.

The front edge of the internal circuit board in the device I/O module contains two-blower status LEDs (see Figure 1–6). Under normal operating conditions, the LEDs are ON. When there is a blower error or an over-temperature condition, they are FLASHING. The upper LED displays the status of the left blower and the lower LED displays the status of the right blower. The blowers cool the device I/O module by drawing air in through the slots in the front and exhausting it out the rear of the shelf. Refer to the StorageWorks SBB Shelf I/O Module User's Guide (part no. *EK-SBBIO-UG*) supplied with the Device Expansion Shelf for a description of the blower status LEDs when troubleshooting a shelf-cooling problem.

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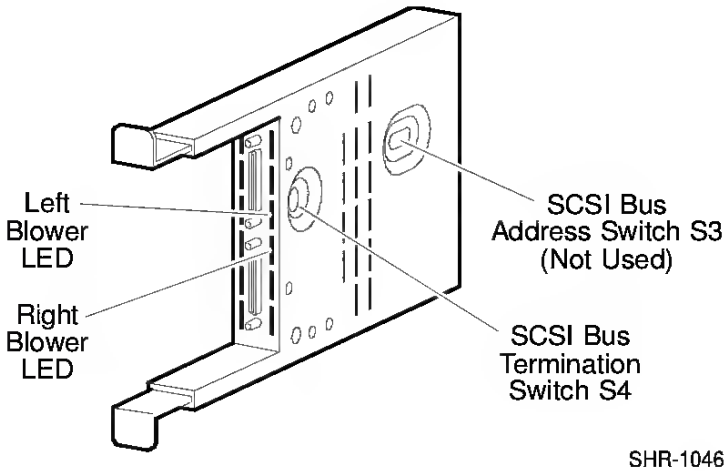
Figure 1–6 Device I/O Module Blower Status LEDs



NOTE

The SCSI bus address switch on the Controller Shelf device I/O module does not control the target addresses of the SBB slots in the Device Expansion Shelves. This switch has been electrically disabled by design. Refer to the StorageWorks SBB Shelf I/O Module User's Guide supplied with the Device Expansion Shelf for a description of how to set the SCSI IDs in each shelf.

SCSI bus termination switch S4 configures the SCSI bus termination of the Device Expansion Shelves in the RAID Array 3000 storage system. The proper settings for S4 are included in the cabling procedures in Chapter 3 of this guide.

1.5.3 Host I/O Module

The Controller Shelf contains two identical Host I/O modules (see Figure 1–7). The module located directly to the left of the device I/O module is designated as H1 and the module in the adjacent slot as H0. The host I/O module provides the interface between the host bus and the controller(s) in the shelf.

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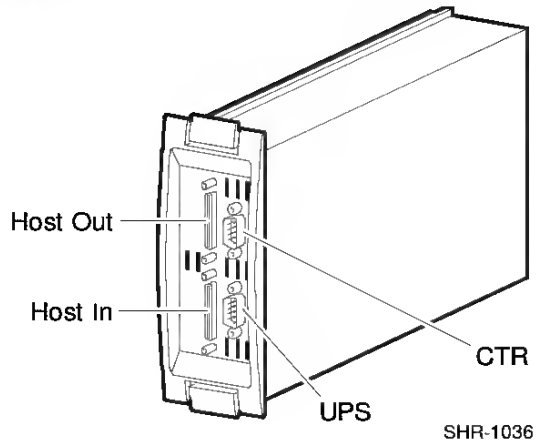
Figure 1–7 Host I/O Module



The front panel of the host I/O module contains two 68-pin VHDCI SCSI connectors and two 9-pin D connectors. The SCSI connectors provide the SCSI bus connections between the adapter in the host system and the controller(s) in the Shelf. One of the 9-pin D connectors interfaces the UPS status signals to the controller. The other provides a serial connection between its respective controller, the Shelf, and the SWCC configuration/maintenance PC.

The high-density SCSI connectors on the Host I/O module are designated *Host In* (bottom connector) and *Host Out* (top connector). *Host In* provides the SCSI connection for a one-to-four expansion shelf cabinet installation. Cable connections to multiple storage shelves are made through Trilink adapters.

In addition to the front panel connectors, the Host I/O module contains three passive differential SCSI bus terminators that terminate the SCSI bus from the host system. Termination is automatically disabled when a cable is connected to the *Host Out* connector. The UPS serial connector on the host I/O module (designated *CTR 0* and *CTR 1*) provides shelf status information to the UPS.

NOTE

If you have only one SCSI cable connection to the host I/O module, you must connect the cable to the *Host In* connector. Do not use any external bus termination. The *Host Out* connector on the module is used for mid-bus connections in a multiple-host system configuration.

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1.5.4 Shelf Cooling

The device I/O module ensures that the SBBs and Controller Shelf are at the proper operating temperature by monitoring the operational status of the blowers and sensing the ambient air temperature.

The two dual-speed blowers cool all the shelf components by drawing ambient air in through the front of the SBBs and exhausting it out the rear of the Controller Shelf. The blowers normally operate at low speed. Reduction of the airflow through the shelf or an increase in the ambient temperature may result in overheating causing component failure or data corruption.

The device I/O module ambient temperature circuitry monitors the air flowing through the module. If the ambient temperature exceeds 32°C + 2° C, the circuitry:

- Turns on both blower LEDs
- Causes both blowers to switch to the high-speed mode to increase air flow through the shelf

When the I/O module circuitry detects a blower that is not operating or not operating at the correct RPM, this circuitry:

- Turns ON a LED on the I/O module front panel that identifies the defective blower
- Causes the operational blower to switch to the high-speed mode to increase air flow through the shelf, thereby maintaining the proper operating environment

NOTE

The Controller Shelf power supply status LEDs also display blower error conditions. However, they do not identify the defective blower, nor do they report ambient air temperature faults.

1.5.5 Controller Shelf Power Supplies

The Controller Shelf has two interchangeable, air-cooled, 180 watt AC power supply SBBs (see Figure 1–8) located at the left two SBB slots of the shelf. The power supplies provide redundant power if one of the units should malfunction. Each supply provides +5 and +12 Vdc to power the RAID controller(s), the host I/O modules, the device I/O module, and the blowers. The first power supply from the left edge of the shelf is designated as "A" and the second as "B". The SBB front panel has an ac input power receptacle, a power supply status LED, and a shelf status LED.

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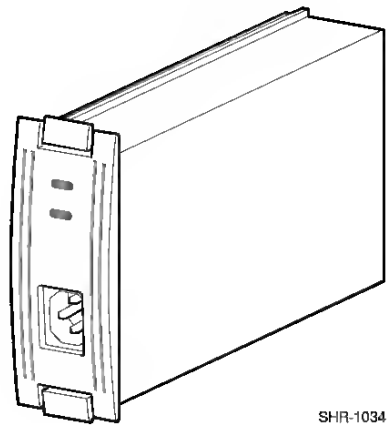
Figure 1–8 Power Supply



1.5.6 Uninterruptable Power Supply (UPS)

The primary function of the UPS is to keep the entire storage system powered-up to enable the controller(s) to flush cache to disks. The UPS also protects the storage system from problems associated with poor quality AC power or a complete loss of AC power. The UPS is normally mounted in a lower shelf slot in the cabinet using a custom set of mounting brackets.

The major features of the UPS include Battery Management Technology (doubles battery life and speeds recharge time), hot-swap batteries to simplify service, voltage regulation, power control which enables scheduled shutdowns and maximized run time, and network surge protection.

The front panel display has user controls (LEDs and control buttons) and the rear panel contains an RS-232 COMM port which provides UPS status to the electronics in the Controller Shelf. The rear panel also contains the network surge protector, and four power receptacles. An audible alarm is activated when input power fails, as a low battery warning, or whenever the UPS is in need of servicing. The front panel control switches are used to set the output voltage level and battery low-warning option.

The UPS automatically recharges its battery when power is returned following a power failure. Recharge time is less than four hours depending on the energy requirements of your load and the length of the power outage.

Its own installation, operation, and service manual support the UPS. The manual describes the UPS in detail and is part of the documentation set enclosed with your storage system.

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1.6 6-Slot Device Expansion Shelf (Optional)

NOTE

The Device Expansion Shelf (DS-SWXRA-GN) must have a revision level of B01 (or higher) to operate with the RAID Array 3000 Controller Shelf. Also, the Personality I/O module supplied with the shelf (part no. 70-33067-02) must have a minimum revision level of H01 or higher.

The RAID Array 3000 Controller Shelf is designed to operate with the StorageWorks BA356-S Series Device Expansion Shelf (shown in Figure 1–2. The Device Expansion Shelf is a rackmount enclosure that houses the storage devices for your storage system installation. The Controller Shelf can be connected to one, or up to four Device Expansion Shelves giving the storage system a maximum capacity of 24 storage devices.

The Device Expansion Shelf is equipped with two dc power supplies, a personality I/O module that provides the UltraSCSI bus interface, and six empty slots for storage device SBBs. The user's guide for the Device Expansion Shelf is packaged with the unit and must be used with this document to properly install and configure the RAID Array 3000 Controller Shelf.

1.7 Connecting the RA3000 Controller Shelf to a Host System

This section illustrates how to connect four possible Controller Shelf/Host configurations. The configurations are:

- Single host, single adapter, with one active controller
- Single host, single adapter, with two active controllers
- Single host, dual adapter, two port with two active controllers
- Dual host, single adapter, with one active controller per host

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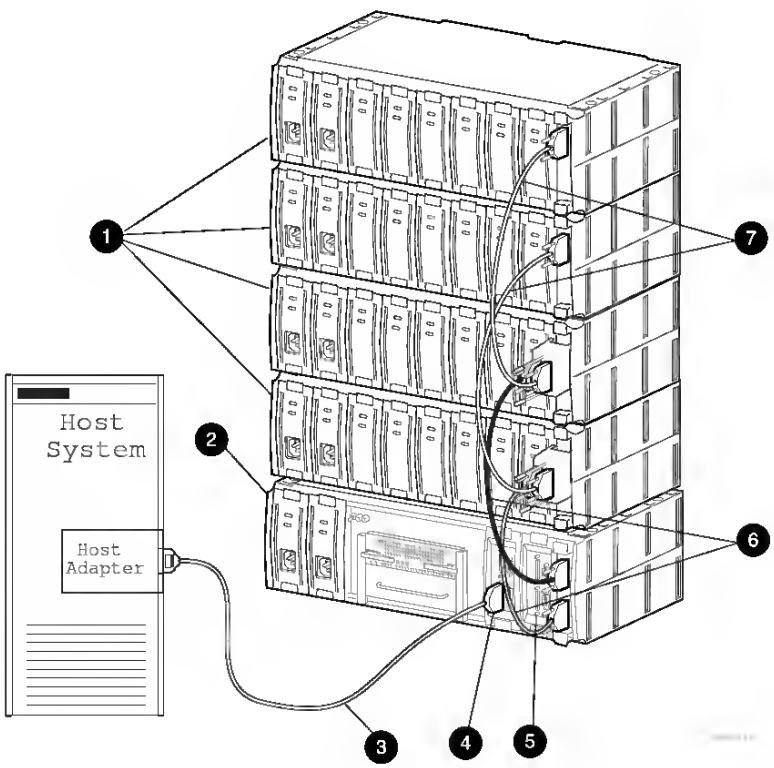
Figure 1–9 Single Host, Single Adapter, with One Active Controller



1 BA356 Device Expansion Shelves

2 RAID Array 3000 Controller Shelf

3 SCSI Cable BN37A-05 (host adapter connection made using Technology Adapter cable BN38E-OB, not shown)

4 Host In Connector on H0 I/O Module

5 Host-In Connector to H1 I/O Module (not used in this configuration)

6 SCSI Cables BN37A-OE (2) for Device I/O Module 0

7 SCSI Cables BN37A-OE (2) for Device I/O Module 1

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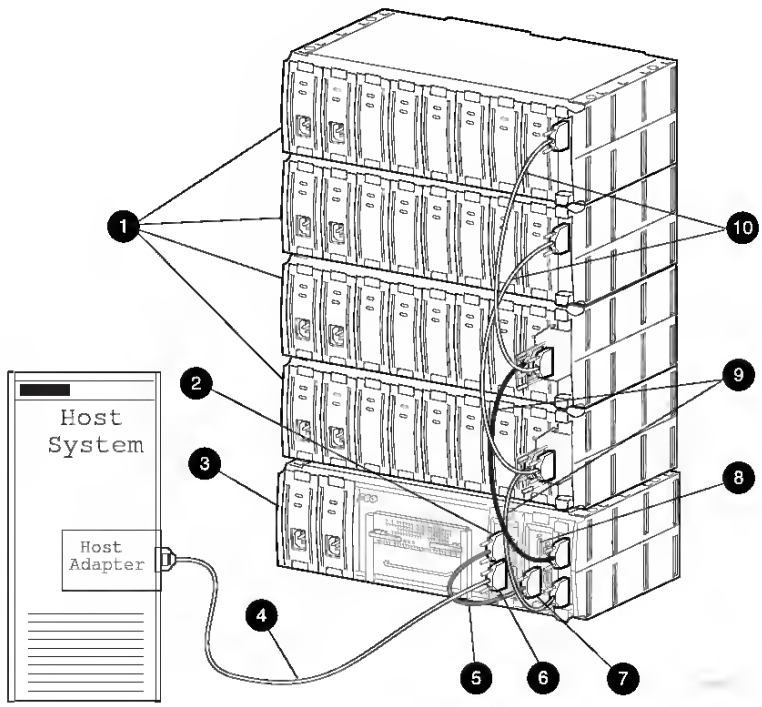
Figure 1–10 Single Host, Single Adapter, with Two Active Controllers



I BA356 Device Expansion Shelves

2 Host In Connector on H0 I/O Module

3 RAID Array 3000 Controller Shelf

4 SCSI Cable BN37A-05 (host adapter connection made using Technology Adapter cable BN38E-OB, not shown)

5 SCSI Cable BN37A-OE combining Host Modules H0 and H1

6 Host In Connector on H0 I/O Module

7 Host In Connector on H1 I/O Module

8 H1 Host I/O Module Host-Out Connector (not used in this configuration)

9 SCSI Cables BN37A-OE (2) for Device I/O Module 0

10 SCSI Cables BN37A-OE (2) for Device I/O Module 1

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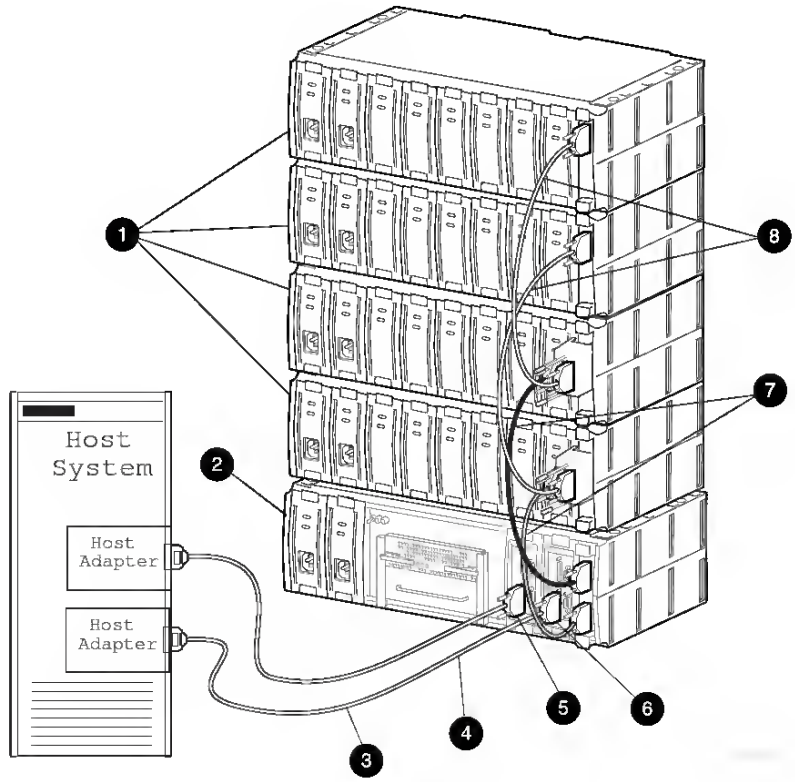
Figure 1–11 Single Host, Dual Adapter, Two Port with Two Active Controllers



1 BA356 Device Expansion Shelves

2 RAID Array 3000 Controller Shelf

3 SCSI Cable BN37A-05 (host adapter connection made using Technology Adapter cable BN38E-OB, not shown)

4 SCSI Cable BN37A-05 (host adapter connection made using Technology Adapter cable BN38E-OB, not shown)

5 Host In Connector on H0 I/O Module

6 Host In Connector on H1 I/O Module

7 SCSI Cables BN37A-OE (2) for Device I/O Module 0

8 SCSI Cables BN37A-OE (2) for Device I/O Module 1

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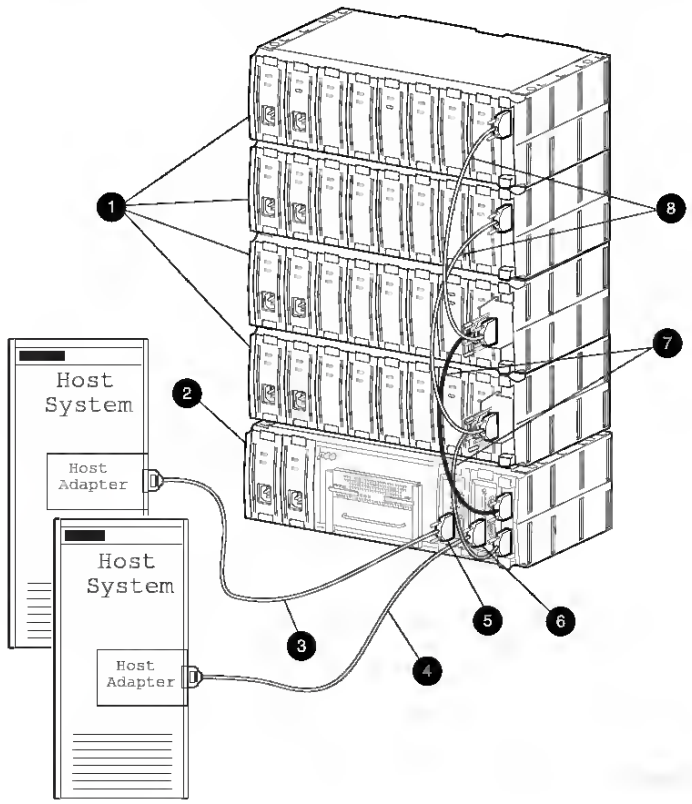
Figure 1–12 Dual Host, Single Adapter, with One Active Controller per Host



I BA356 Device Expansion Shelves

2 RAID Array 3000 Controller Shelf

3 SCSI Cable BN37A-05 (host adapter connection made using Technology Adapter cable BN38E-OB, not shown)

4 SCSI Cable BN37A-05 (host adapter connection made using Technology Adapter cable BN38E-OB, not shown)

5 Host In Connector on H0 I/O Module

6 Host In Connector on H1 I/O Module

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7 SCSI Cables BN37A-OE (2) for Device I/O Module 0

8 SCSI Cables BN37A-OE (2) for Device I/O Module 1

1.8 Specifications

Table 1–2 Controller Shelf Technical Specifications

Feature	Description
Model	RA3000 rack mount controller shelf (DS-SWXRA-GH, -GK) RA3000 rack mount disk shelf (DS-SWXRA-GN)
Controller shelf description	BA356 style shelf with one HSZ22 controller, two 180 Watt power supplies, two host I/O modules, one dual channel Ultra –wide, single ended personality module, blue
Disk controller shelf	BA356 disk SBB shelf with two 180 Watt power supplies, one single channel Ultra –wide, single ended personality module, blue
Controller model	One HSZ22 standard
Dual active controllers	Yes with DS-HSZ22 second controller upgrade
Controller cache	16 MB standard 64 MB standard with two controllers
Backup for cache	1000 VA "Uninterruptable Power Supply", standard with controller shelf
Controller operation (with 2 controllers)	Active-active (recommended) Active-passive (spare)
Controller failover	Yes, automatic
Mirrored write-back cache	Yes
Write through cache	Yes
Command Queuing	Yes, 64 commands
Write gathering	Yes
Host channels	Two UltraSCSI Wide Differential
Drive channels	Two UltraSCSI Wide Single ended
Maximum transfer rate	44.7 MB per second per controller pair
RAID 5 sustained transfer rate	Read – 32.6 MB per second per controller pair Write – 30.6 MB per second per controller pair

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Table 1–2 Shelf Technical Specifications (continued)

Feature	Description
Maximum I/O per second	4,400 I/O per second
Sustained Raid 5 I/O rate -- 2 KB block transfers	Read -- 1,375 I/O per second per controller pair Write – 392 I/O per second per controller pair
RAID levels supported	0, 1, 0+1, 4, 5
Non-RAID disk support (JBOD)	Yes
Reconstruct time	Configurable with SWCC
Stripe size / chunk size	Variable
Maximum Logical Drives (LUNs)	Up to 30 RAID sets Up to 16 redundancy groups (LUNs) per RAID set
Maximum disk/ RAID sets	Two, 32 blocks. Theoretical 2.2 petabytes; restricted by drive capacity
Boot from RAID set	Yes, operating systems dependent
Passthrough to tape, CD	Not supported
Maximum number of disks	24 in four disk shelves
Maximum disks per device port	12
Global spare	Yes
Drive support	2, 4, 9, 18 GB Wide UltraSCSI drives in SBB
Redundant fans	Yes
Drive reconstruct	Automatic with spare
Disk hot swap	Yes
Redundant power supplies	Yes
Environmental monitoring	Yes, monitors power and temperature
Setup/control lines	1 Serial per controller
Serviceability	Hot swap components
RAID Manger GUI support	StorageWorks Command Console V2.0 (SWCC) available for all platforms.

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Table 1–2 Shelf Technical Specifications (continued)

Feature	Description
Regulatory approvals	EMI/R I -- FCC Class A, CSA 108.8 Class A, VCCI level 1, BICQ Class A, CISPR-22 Class A, C-Tick Class A Safety -- UL 1950 3rd edition, AS/NZ 3260, IEC 950 CSA 22.2 #950,1995, EN60950/A3:1995, VDE 0905, TUV, GS Mark, CE mark

Table 1–3 Controller Shelf Power and Physical Specifications

Operating Environment	Specification	
Power required	110-120/220-240 VAC, 50/60 Hz, Single Phase, Two 180 Watt power modules @ 2.5 / 1.2 A each	
Temperature -- optimal, Temperature --minimum required	18 to 24° C (65 to 75° F) 10 to 40° C (50 to 104° F)	
Relative humidity – optimal Relative humidity – minimum required	40% to 60% non condensing 10% to 90% non condensing Maximum wet bulb temperature 28° C (82° F) Minimum dew point: 2° C (36° F)	
Altitude	Up to 8,000 ft (2,400 m)	
Inlet air volume	0.026 cubic meter per second (50 cubic feet per minute)	
Air quality	Not to exceed 500,000 particles per cubic foot of air at a size of 0.5 micron or larger	
Non-operating Environment [1]		
Temperature	-40 to +66° C (-40 to 151° F)	
Relative humidity	8% to 95% non condensing in original shipping container	
Altitude	From –300 m to 3,600 m (-1,000 ft. to 12,000 ft)	
Physical Characteristics[1]	Installed Dimensions	
	Controller and disk shelves	UPS
- Height	150 mm (5.9 in) /4 U	8.9mm (3.5 in) /2U
- Width	445 mm (17.5 in)	48.2mm (19 in)
- Depth	350 mm (13.8 in)	40.6mm (16.0 in)
- Weight	Controller shelf 9.5kg (21 lbs.) Disk shelf 7.3 kg.(16 lbs.)	UPS 27kg (58 lbs.)

(1) Disk SBBs not included

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2

RAID Array Controller

This chapter describes the major features and characteristics of the RAID array controller in the controller shelf.

2.1 Controller Overview

The RAID Array controller provides high performance, high-availability access to SCSI disk array subsystems along a wide UltraSCSI bus. With a modular hardware design and an intuitive configuration utility, the controller is designed to meet a wide range of storage needs.

The controller consists of a single 5 1/2" x 8" circuit board mounted in a subassembly. The package consists of the controller board, a 300-pin connector, mechanical insertion assists, and a front panel LED/reset switch interface. All signals to the controller are routed through the backplane connector.

Figure 2–1 shows a simplified block diagram of the controller and its interfaces to the major components in the RAID Array 3000 . The unit is configured with two Ultra-Wide, differential, SCSI host channels capable of transferring data to and from the host at rates up to 40 MB/s. The host SCSI IDs are configurable via the Host Parameters and can support 32 deep tagged queuing. The controller is also configured with two Ultra-Wide, single-ended, SCSI disk channels capable of transferring data to and from the disk drives at rates up to 40 MB/s. Each channel can support up to 12 drives.

The controller has two SIMM connectors. The connectors form a mirrored pair when the controllers are configured in a redundant controller configuration; otherwise they are fully accessible by the controller. In a redundant controller setup, both controllers must have identical cache configurations and the total usable cache (per controller) will be half the amount installed. Thus, in a single controller setup the maximum usable cache is 128 MB while a redundant setup has a maximum usable cache of 64 MB (per controller).

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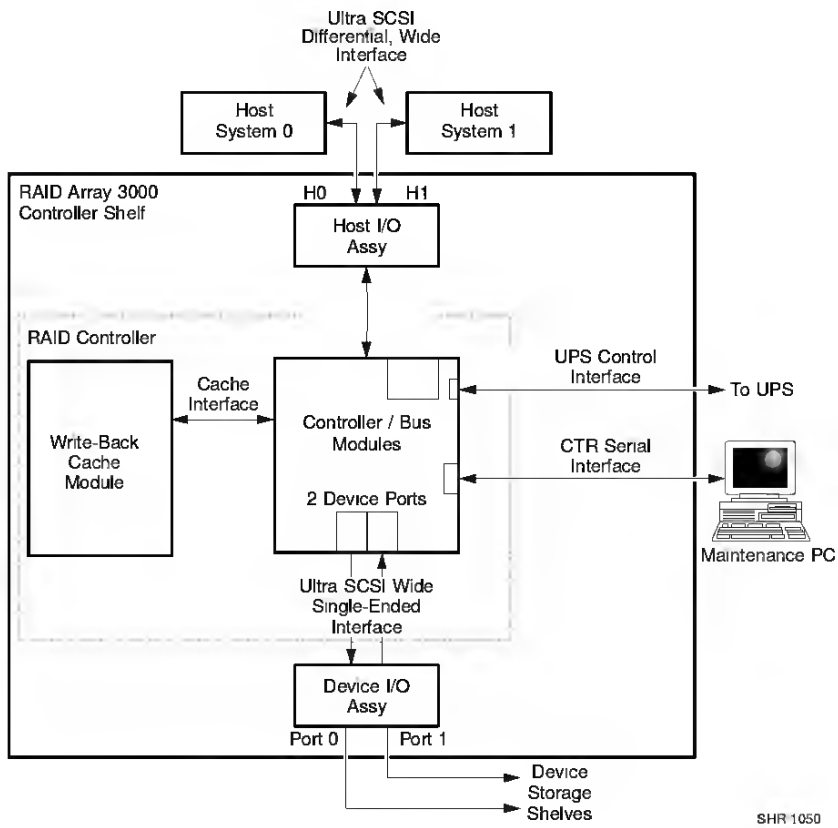
Figure 2–1 RAID Array 3000 Single Controller Block Diagram



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There are two configurations for redundant pairs of controllers: Active/Active Failover mode and Active/Passive Failover mode. In Active/Active Failover, each controller in the redundant pair has one active SCSI host port and one passive SCSI host port. Redundancy Groups (Virtual LUNS) can be mapped only to one active host port and are not accessible from the passive port or the other controller (i.e. partitioned model).

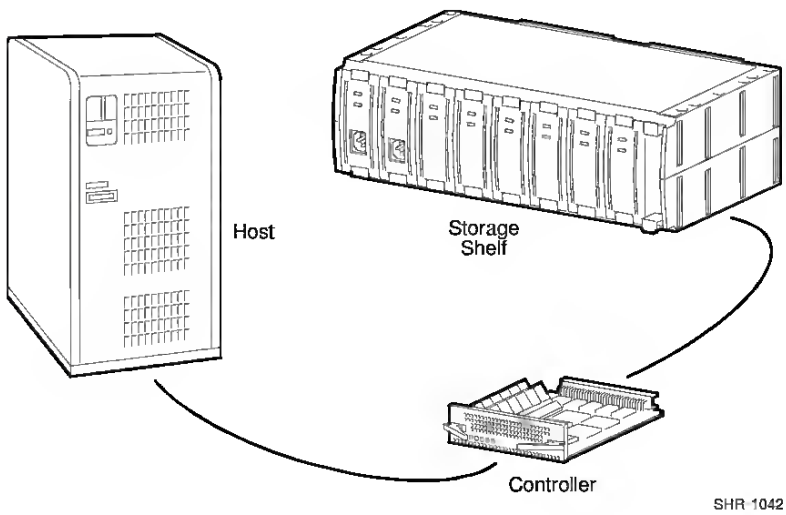
In Active/Passive Failover, one controller in the redundant pair has both SCSI host ports active and the other controller is in a standby passive mode. Redundancy Groups (Virtual LUNs) can be mapped to either SCSI host port or to both as in the single controller model.

In both cases a single controller failure will not affect the subsystem because the surviving controller will take over.

2.2 Controller Features

The controller is the intelligent bridge between the host and the devices in the shelf. From the host's perspective, the controller is simply another SCSI device connected to one of its I/O buses. Consequently, the host sends its I/O requests to the controller just as it would to any other SCSI device. Figure 2–2 shows the role of the controller between the host and the Device Expansion Shelf.

Figure 2–2 Bridging the Gap Between the Host and Device Expansion Shelf



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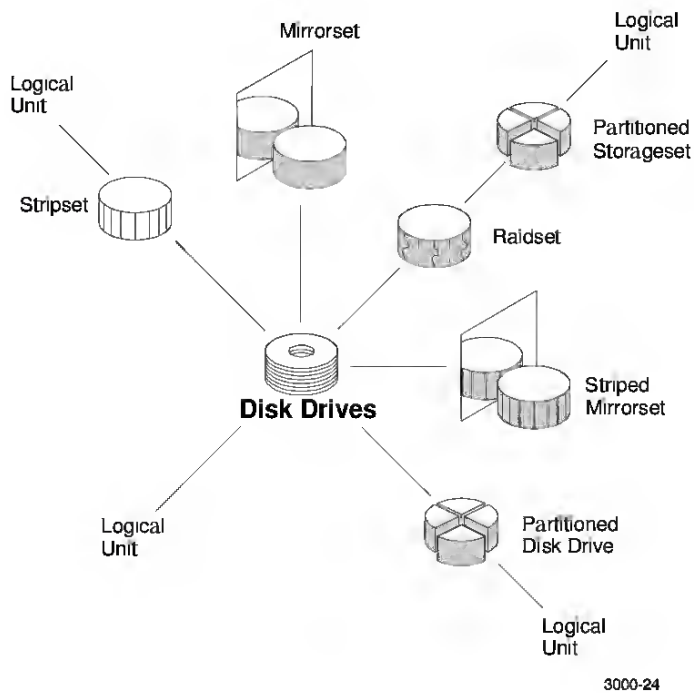
From the storage shelf's perspective, the controller receives the I/O requests from the host and directs them to the devices. Since the controller processes all the I/O requests, it eliminates the host-based processing that is typically associated with reading and writing data to multiple storage devices.

The controller does much more than simply manage I/O requests: it provides the ability to combine several ordinary disk drives into a single, high-performance storage unit called a storageset. Storagesets are implementations of RAID technology, also known as a "Redundant Array of Independent Disks". Every storageset shares one important feature: whether it uses two disk drives or 12, each storageset looks like a single storage unit to the host.

You create storage units by combining disk drives into storagesets such as stripesets, RAIDsets, and mirrorsets, or by presenting them to the host as single-disk units (see Figure 2–3).

Figure 2–3 Logical Units Created from Storagesets, Partitions, and Disk Drives



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- Stripesets (RAID 0) combine disk drives in serial to increase transfer or requests rates
- Mirrorsets (RAID 1) combine disk drives in parallel to provide a highly reliable storage unit
- RAID 4 provides striping with a fixed parity drive
- RAIDsets (RAID 5) combine disk drives in serial - just like stripesets - but also store parity data to ensure high reliability
- Stripe mirrorsets (RAID 0 + 1) combine mirrorsets in serial to provide the highest throughput and availability of any storage unit

2.3 Controller Reset and LED Indicators

Figure 2–4 illustrates the front panel of the controller. All LEDs are numbered from left to right. The reset button (LED 0) flashes green about once every second (heartbeat) to indicate that the controller is operating normally. LEDs 1 through 4-display host and disk channel activity (amber). LED 5 (normally off) comes on red during a controller failure. The LED/Reset switch interface is defined in Table 2–1.

Table 2–1 LED/Reset Switch Interface

LED #	Name
0	Heart Beat/LED Controller Reset Switch (green)
1	Host Channel 0 Activity LED (amber)
2	Host Channel 1 Activity LED (amber)
3	Disk Channel 0 Activity LED (amber)
4	Disk Channel 1 Activity LED (amber)
5	Fault LED (red)

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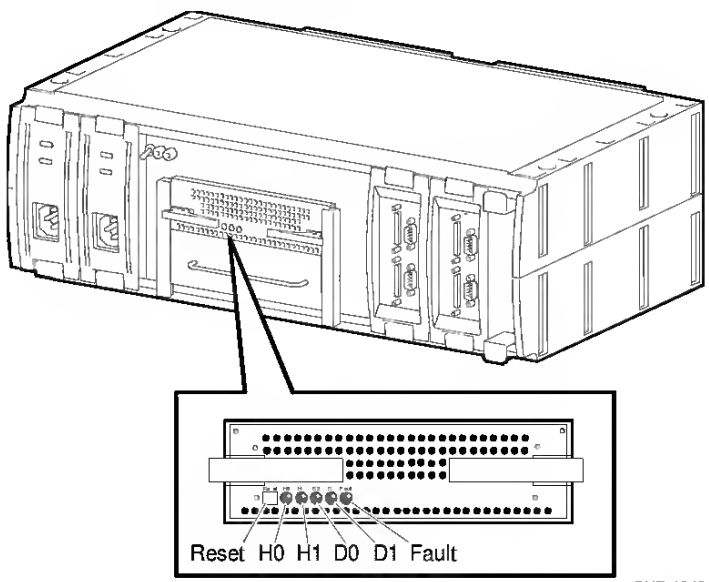
Figure 2–4 Controller Front Panel



2.4 Flexible RAID Set Configuration

In addition to its flexible hardware design, the controller's firmware offers the user the flexibility to configure RAID sets in several different ways:

- RAID sets can comprise drives from any drive channel and SCSI ID.
- A RAID set can contain all the drives connected to the controller, a single drive, or any number of drives in between.
- The controller supports RAID Levels 0, 1, 0+1, 4, and 5. It also supports JBOD (Just a Bunch of Drives), allowing you to connect standalone disk drives (such as a system disk) to the controller without making them members of a RAID set.
- Each RAID set can be partitioned into smaller redundancy groups.
- Any drive may be designated as a spare. Spares are global, meaning that in the event of a drive failure, the controller will search for the first available spare on any channel or SCSI ID and automatically begin rebuilding the failed drive's data.
- All configuration and monitoring of RAIDsets accomplished via SWCC with software platform kit.

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2.5 Performance Enhancements

The controller employs a number of techniques to achieve as much performance as possible from its design.

2.5.1 Custom Components

To increase performance and reliability, the controller's core functions have been encapsulated in four custom ASIC (Application Specific Integrated Circuits) components as follows:

XOR ASIC: Used in the Exclusive -Or parity calculations employed by RAID levels 4 and 5.

DMA ASIC: Controls the data path hardware for the various I/O ports

CPU Interface ASIC: Supports the controller's MIPS R3000 RISC central processing unit.

Memory Controller ASIC: Controls the memory system and supports data movement on the internal bus at a maximum burst rate of 80 MB/second and a maximum sustainable rate of 60 MB/second.

2.5.2 Efficient Write and Read Algorithms

Standard RAID write operations that involve parity, such as those in RAID levels 4 and 5, require multiple, time-consuming steps:

1. Read data from the parity drive.
2. Read existing data from the target data drives.
3. Exclusive-Or the old parity, old data, and new data to generate new parity data.
4. Write the new parity data to the parity drive.
5. Write the new data to the target data drives.

The controller uses several techniques to streamline write operations and significantly improve performance. All the techniques use the controller's on-board cache 60-nanosecond SIMMs.

NOTE

The controller will not operate without at least one 16 MB SIMM installed in its cache. Nor will it operate without an un-interruptable power supply connected to the controller. Without a UPS, data stored in the cache, but not yet written to the disk drives, would be lost in the event of a power interruption.

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2.5.2.1 Write-Back Caching

When the host sends data to be written to a redundancy group the controller stores the data in its cache and immediately reports to the host it has completed the write. The controller eventually writes the data to the disk drives when the write can be done most efficiently, or when the controller must flush the cache to make room for other data or to prepare for a shutdown.

Write-back caching makes the host more responsive to the user, since the host does not have to wait for a lengthy RAID write before proceeding to another task.

2.5.2.2 Write Gathering

The controller will attempt to consolidate multiple writes destined for contiguous blocks and then write the entire data block in one operation. The controller stores the data in cache until it performs the write. Ideally, the controller will wait until it has gathered enough data to fill an entire stripe. This enables the controller to avoid reading from the parity and data drives before making the write. All it has to do is calculate parity from the data it already has in its cache, then write the data and parity to the drives. Even if the controller cannot accumulate enough data to fill a stripe, the consolidation of small writes can reduce the number of read/write operations that must take place.

2.5.2.3 Write On Top

If the host commands that data be written to disk, and data for that address is pending in the controller's cache, the controller writes the new data on top of the old in the cache. Only the new data is eventually written to the disk drives.

2.6 RAID Levels Supported

The RAID Array 3000 controller supports the following RAID levels:

Table 2–2 RAID Levels Supported

RAID Level	Description
0	Striping without parity
1	Mirroring
0+1	Striping and mirroring
4	Striping with fixed parity drive
5	Striping with floating parity drive
JBOD	"Just a Bunch of Drives"

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There are some restrictions you must adhere to when creating a RAID set using the RAID 3000 shelf. The minimum and maximum number of drives required to support each RAID level is listed in Table 2–3.

Table 2–3 Shelf RAID Set Restrictions

RAID Level	Min. No. of Drives	Max. No. of Drives
JBOD	1	1
0	2	24
1	2	24
0+1*	4	16
4	3	24
5	3	24

*Must be even number.

2.6.1 RAID 0

RAID 0 breaks up data into smaller chunks and writes each chunk to a different drive in the array. The size of each chunk is determined by the controller's chunk size parameter, which you set in the course of creating a RAID set.

The advantage of RAID 0 is its high bandwidth. By breaking up a large block of data into smaller chunks, the controller can use multiple drive channels to write the chunks to the disk drives. Furthermore, RAID 0 involves no parity calculations to complicate the write operation. Likewise, a RAID 0 read operation employs multiple drives to assemble a single, large data block. This makes RAID 0 ideal for applications such as graphics, video, and imaging that involve the writing and reading of large, sequential blocks. Figure 2–5 shows a diagram of a RAID 0 write.

CAUTION

The lack of parity means that a RAID 0-disk array offers no redundancy and thus cannot recover from a drive failure.

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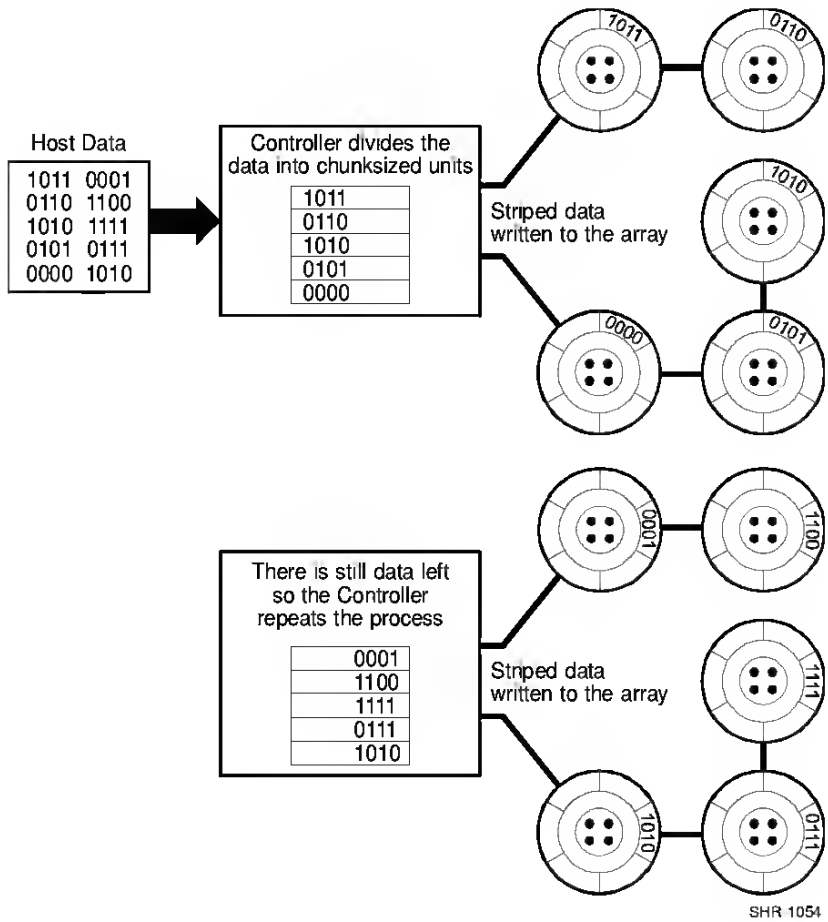
Figure 2–5 RAID 0 Write



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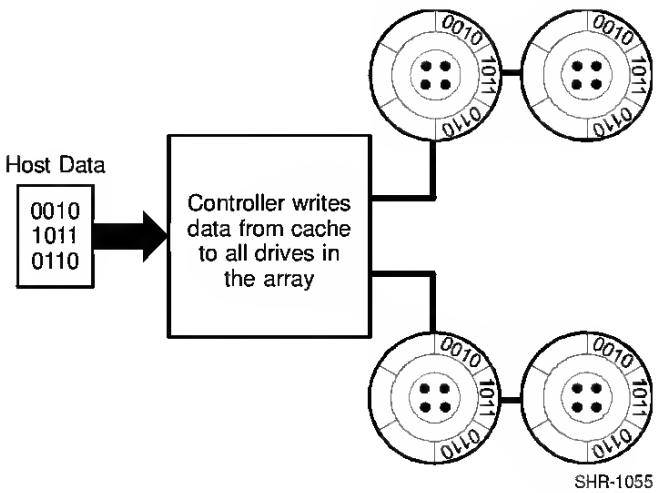
2.6.2 RAID 1

RAID 1 (also known as mirroring or shadowing) takes data sent by the host and duplicates it on all the drives in an array. The result is a high degree of data availability, since you can lose all but one drive in the array and still have full access to your data. This comes at a price: a RAID 1 array requires multiple drives to achieve the storage capacity of a single drive. Figure 2–6 illustrates a RAID 1 write.

Figure 2–6 Diagram of a RAID 1 Write



A RAID 1 array will show up on the monitor as "degraded" when at least one drive fails, even if two or more members of the redundancy group remain in good working order. As long as at least two working drives remain in the array, you may continue to run the array in degraded mode without putting data in jeopardy.

2.6.3 RAID 0+1

RAID 0+1 (see Figure 2–7) combines RAID 0 (striping) with RAID 1 (mirroring). In RAID 0+1 write, the controller breaks up the data block from the host into smaller chunks, then writes the chunks to half the drives in the array, while writing duplicate chunks to the remaining drives.

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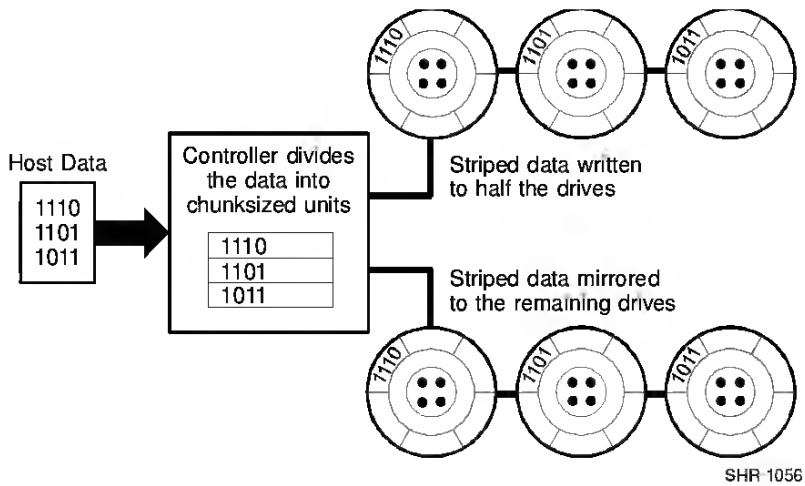
Figure 2–7 Diagram of RAID 0+1 Write



In the event of a drive failure, a RAID 0+1 array will enter degraded mode and continue to operate by substituting the failed drive with its mirror.

When the controller creates a RAID 0+1 set, it first sorts the drives by channel number and SCSI ID. Then it stripes the data across every other drive and forms a mirrored pair with the first two drives, another mirrored pair with the second two drives, and so on. Table 2–4 describes how the controller uses the drives in a RAID 0+1 set.

Table 2–4 RAID 0+1 Example

Drives Selected	Function
Channel 1, ID 0	First member of stripe set
Channel 1, ID 1	Mirror of channel 1, ID 0
Channel 1, ID 2	Second member of stripe set
Channel 2, ID 0	Mirror of channel 1, ID 2
Channel 2, ID 1	Third member of stripe set
Channel 2, ID 2	Mirror of channel 2, ID 1

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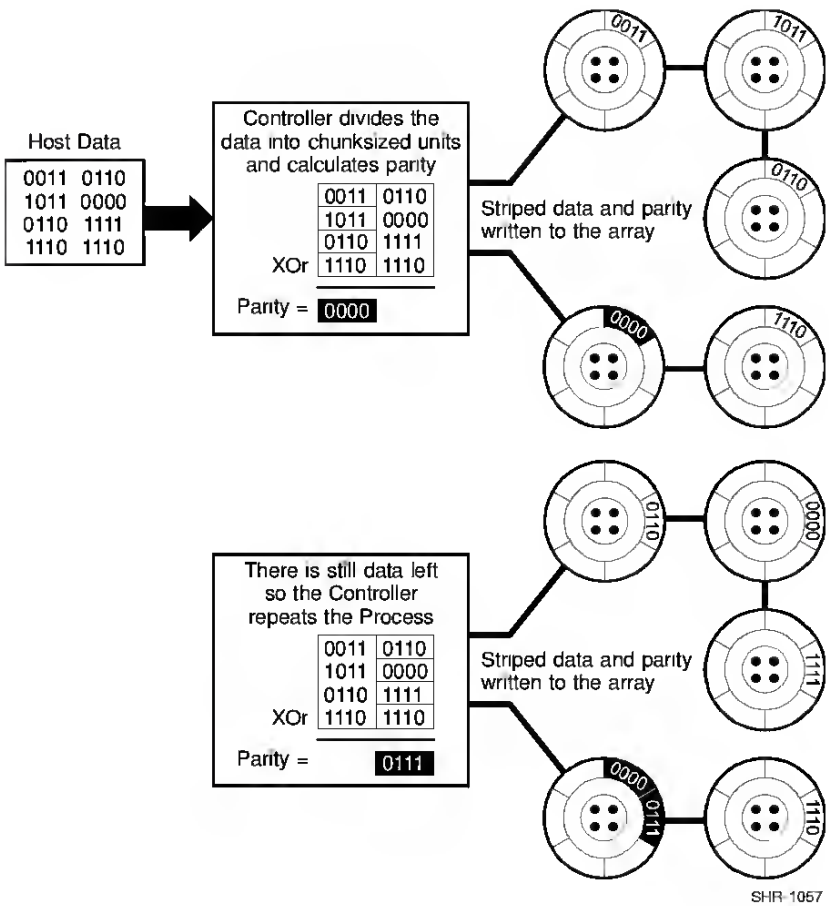
2.6.4 RAID 4

RAID 4 (Figure 2–8) breaks up host data into chunks, calculates parity by performing an exclusive-or on the chunks, and then writes the chunks to all but one drive in the array and the parity data to the last drive. When the host requests data from the disk drives, the controller retrieves the chunks containing the addressed data, reconstitutes the data from the chunks, and passes the data to the host.

Figure 2–8 Diagram of a RAID 4 Write



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In the event of a single drive failure, a RAID 4 array will continue to operate in degraded mode. If the failed drive is a data drive, writes will continue as normal, except no data will be written to the failed drive. Reads will reconstruct the data on the failed drive by performing an exclusive-or operation on the remaining data in the stripe and the parity for that stripe. If the failed drive is a parity drive, writes will occur as normal except no parity will be written. Reads will simply retrieve data from the data disks. There will be no deterioration in controller performance while a RAID set is in degraded mode.

In general, RAID 4 is best suited for applications such as graphics, imaging, or video that call for reading and writing large, sequential blocks of data. However, you may find that RAID 4 is preferable to RAID 5 even for applications characterized by many small I/O operations, such as transaction processing. This is due to the controller's intelligent caching, which efficiently handles small I/O reads and writes, and to the relatively less complex algorithms needed to implement RAID 4.

The benefits of RAID 4 disappear when you have many, small I/O operations scattered randomly and widely across the disks in the array. RAID 4's fixed parity disk becomes a bottleneck in such applications, as the following example illustrates. Let's say the host instructs the controller to make two small writes. The writes are widely scattered, involving two different stripes and different disk drives. Ideally, you would like both writes to take place at the same time, but RAID 4 makes this impossible, since the writes must take turns accessing the fixed parity drive. For this reason, RAID 5 is the better choice for widely scattered, small write operations.

CAUTION

RAID 4 can withstand a single failure and handle I/O activity without interruption in degraded mode until the failed drive is rebuilt. If a second drive fails while the RAID set is in degraded mode, the entire RAID set will fail.

2.6.5 RAID 5

RAID 5 (Figure 2–9) addresses the bottleneck issue for barrages of widely scattered, small I/O operations. Like RAID 4, RAID 5 breaks up data into chunks, calculates parity, and then writes the chunks in stripes to the disk drives, saving one drive one each stripe for the parity data. Unlike RAID 4, however, RAID 5 changes the parity drive on each stripe. This means, for instance, that a write operation involving drive 2 on stripe 1 can conceivably take place at the same time as a write involving drive 3 on stripe 2, since they would be addressing different parity drives.

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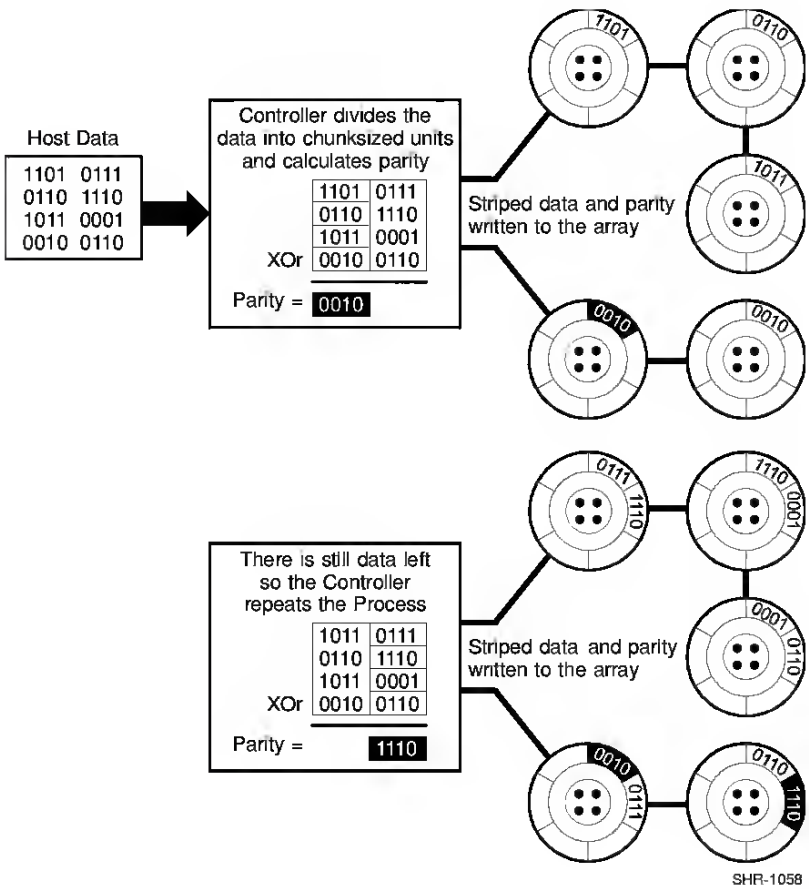
Figure 2–9 Diagram of a RAID 5 Write



RAID 5 handles drive failures in the same manner as RAID 4, except the parity is different for each stripe. The controller either uses the parity information on a stripe to reconstruct its data or simply reads the data as normal, depending on the location of the stripe's parity drive.

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While RAID 5 is ideally suited for applications with many, small I/O operations, there is no reason why it cannot function equally well for applications with large, sequential I/O operations. This makes RAID 5 an excellent all-purpose RAID level.

CAUTION

RAID 5 can withstand a single failure and handle I/O activity without interruption in degraded mode until the failed drive is rebuilt. If a second drive fails while the RAID set is in degraded mode, the entire RAID set will fail.

2.6.6 JBOD

JBOD, which stands for "Just a Bunch of Disks", makes it possible to connect one or standalone disk drives to the controller. A JBOD disk drive is not part of a redundancy group, even though the controller assigns a redundancy group number to the drive. This number becomes that logical unit number (LUN) that the host will use to address the drive.

One use for JBOD is to connect a system disk drive to the controller. The drive does not become part of a RAID set, but it is made available to the host on the same SCSI bus as the other devices controlled by the controller.

2.7 System Parameters

The system parameters allow the user to customize certain aspects of the controller via the SWCC Graphical User Interface.

2.8 Redundant Operation

When operating in a redundant configuration, the two controllers are linked such that, in case of a failure, the surviving controller can access the other controller's cache memory and complete all operations that were in progress when the failure occurred. The controllers support two different configurations:

- **ACTIVE / ACTIVE**: One host port is active on each controller. The other port on each controller is passive and only used if the peer controller fails. This configuration is recommended.
- **ACTIVE / PASSIVE**: Both host ports on one controller are active. The other controller's ports are both passive and only used if the primary controller fails.

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When one controller fails, the survivor will process all I/O requests until the failed controller is repaired and powered on. The subsystem will then return to its previous state (i.e., ACTIVE / ACTIVE or ACTIVE / PASSIVE).

2.8.1 Initialization

During initialization, the firmware in the RAID 3000 verifies that both controllers have consistent configurations including identical memory cache and system parameters. If the controller setups are incompatible, the set is not bound and each controller operates in stand-alone mode.

2.8.2 Message Passing

Information is shared between the two controllers by a collection of messages passed through the backplane connectors. The messages provide configuration data as well as a heartbeat which is transmitted by each controller every 500 ms. If a controller does not receive a heartbeat within one second, it assumes the peer controller has become inoperable and begins failing over.

If the controllers cannot exchange messages due to communication problems over the backplane, they will break the connection and each controller will switch to a stand-alone mode.

2.8.3 Failover

Failover describes the process of transferring data from a failed controller to a survivor and completing any active tasks. When one controller begins the failover process, it sends a reset to the other controller, which prevents the failing unit from processing any more information and enables any host ports that are passive. It then downloads the failed controller's cache to its unused portion of cache and begins acting upon that data.

While downloading the data, the controller responds to I/O by disconnecting (if allowed) and waiting approximately three seconds before reconnecting and presenting a BUSY status. The delay is to prevent host operating systems from seeing too many errors and fencing off the controller.

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2.9 Environmental

The controller incorporates a set of on board sensors to detect abnormal operating conditions that may affect data safety.

2.9.1 Backup Power Management

The controller must be connected to the Uninterruptable power supply (UPS) to prevent the subsystem cache from being corrupted during unexpected losses of power. If no backup power supply is provided, the controller will remain off-line and reject all I/O requests with a status of Check Condition/Hardware Error.

During normal operation, RAID 3000 ac power is supplied from a line source through both power cords to both power supplies. Conditions of poor or no power causes the following UPS responses:

Table 2–5 Response to Various AC Power Conditions

Condition	Response
Low line voltage	UPS compensation circuit automatically increases output voltage, without placing load on the UPS battery.
No line voltage (AC loss)	UPS switches to the battery which supplies power to the RAID 3000 maintaining full functionality. UPS signals RAID 3000 controller of impending power down. Caching is disabled but the RAID 3000 continues to service host requests and begins to flush cache to disk.
UPS low-battery warning	UPS signals RAID 3000 controller of impending power down. Subsystem discontinues host services. Cache flush is completed.
UPS power down	UPS shuts itself off, preventing complete battery discharge. All data has been written to disk.

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3

Installation and Maintenance

This chapter describes how to install the Controller Shelf in a RETMA or metric-style storage cabinet and then make the cable connections to the UPS, Device Expansion Shelves and host system. The maintenance section describes how to interpret the status of the LEDs on the front panel of the Controller Shelf. The chapter also describes how to replace a Field Replaceable Unit (FRU).

3.1 Installation Guidelines

The Controller Shelf installation process consists of mounting the support brackets for the specific number of shelves in your subsystem configuration, setting the UltraSCSI bus termination and target ID addresses, and making the power and SCSI cable connections between the rackmount components. The section is divided into four separate cabling procedures, one for each of the number of Device Expansion Shelves in your specific subsystem configuration.

CAUTION

To prevent the possible loss of data, always shutdown your subsystem from the StorageWorks Command Console (SWCC). **Do not turn off system power before *shutdown* is issued.** When shutdown is issued from SWCC, the controller first flushes the cache to the disk drive, then stops blinking.

Use the following guidelines when installing the Controller and Device Expansion Shelves. They apply to both RETMA and metric cabinet designs.

- For stability and safety, arrange the components in the cabinet using a bottom-up approach.
- Cable length is critical when locating the shelves in the cabinet. Keep shelves grouped together to minimize cable length problems.

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- Install the UPS below the shelves and as low as possible in the cabinet.
- Ensure there is a approximate two-inch gap between the bottom of the controller shelf and the UPS to allow cable routing between the front panel connectors and connectors at the back of the units.

3.2 Installing Shelves in the Cabinet

Determining the best location to install the Controller and Device Expansion Shelves in the cabinet depends on the number of expansion shelves in your subsystem configuration. The shelves should be grouped as shown Figures 3–1 through 3–4. Figure 3–1 shows a single Device Expansion Shelf installation. Figures 3–2, 3–3, and 3–4 show a two, three, and four shelf installation, respectively.

Install the UPS at the bottom of the cabinet with the subsystem shelves directly above. The host system (not shown) can reside between the UPS and the subsystem shelf group.

Note that the Controller Shelf in each figure is located directly below the first Device Expansion Shelf. This minimizes the distance between the connectors to enable the 0.5 meter SCSI cable connections between the modules in the Controller Shelf and each Device Expansion Shelf.

NOTES

- The distance between shelves should not exceed one 1.5 inches.
- Because of power cord lengths, the distance between the last Device Expansion Shelf at the top of a shelf group and the UPS should not exceed 45 inches.

The target SCSI bus addresses of the drives in the Device Expansion Shelves (shown on each storage device in Figures 3–1 through 3–4) are controlled by a switch on the side of the personality I/O module in each expansion shelf. In a single expansion shelf configuration, the IDs are 0–5. In a double expansion shelf configuration, the IDs in both expansion shelves are also 0–5 because each shelf is connected to a separate device I/O bus from the controller.

In a three and four-shelf configuration (Figures 3–3 and 3–4, respectively), the second expansion shelf on each device I/O bus is connected to the first via a Trilink adapter and must be set to 8–13.

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Figure 3–1 Recommended Single Expansion Shelf Installation

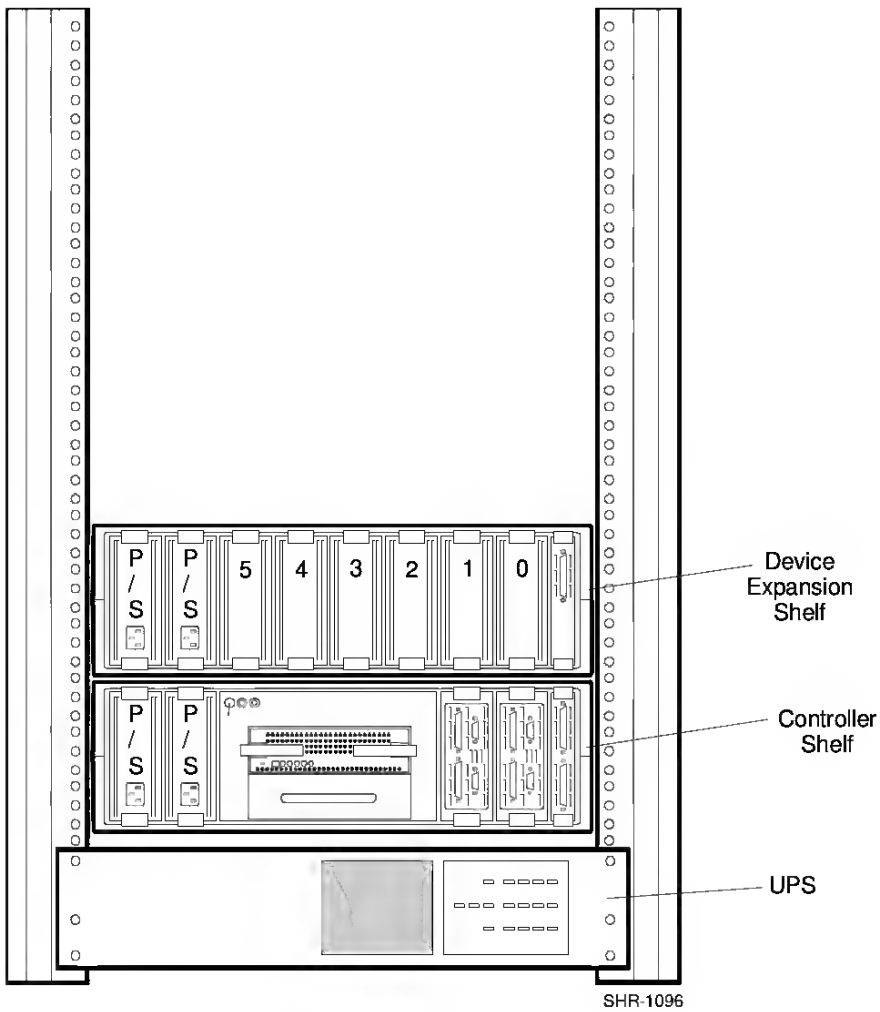

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Figure 3–2 Recommended Controller Shelf Installation (Two Expansion Shelves)

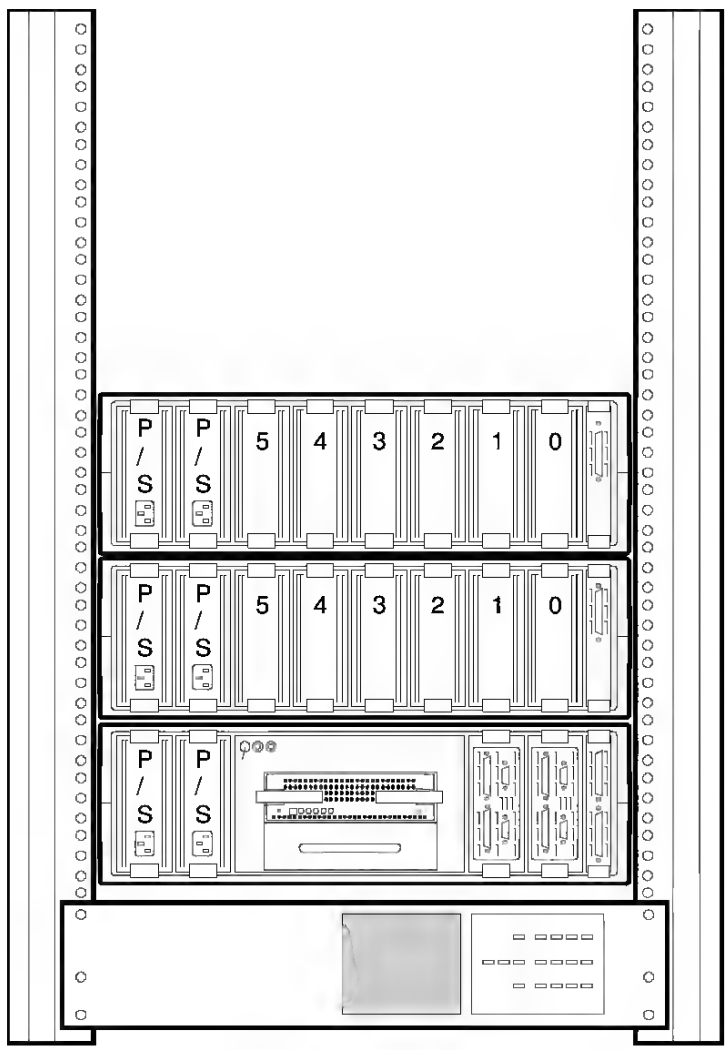

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Figure 3–3 Recommended Controller Shelf Installation (Three Expansion Shelves)

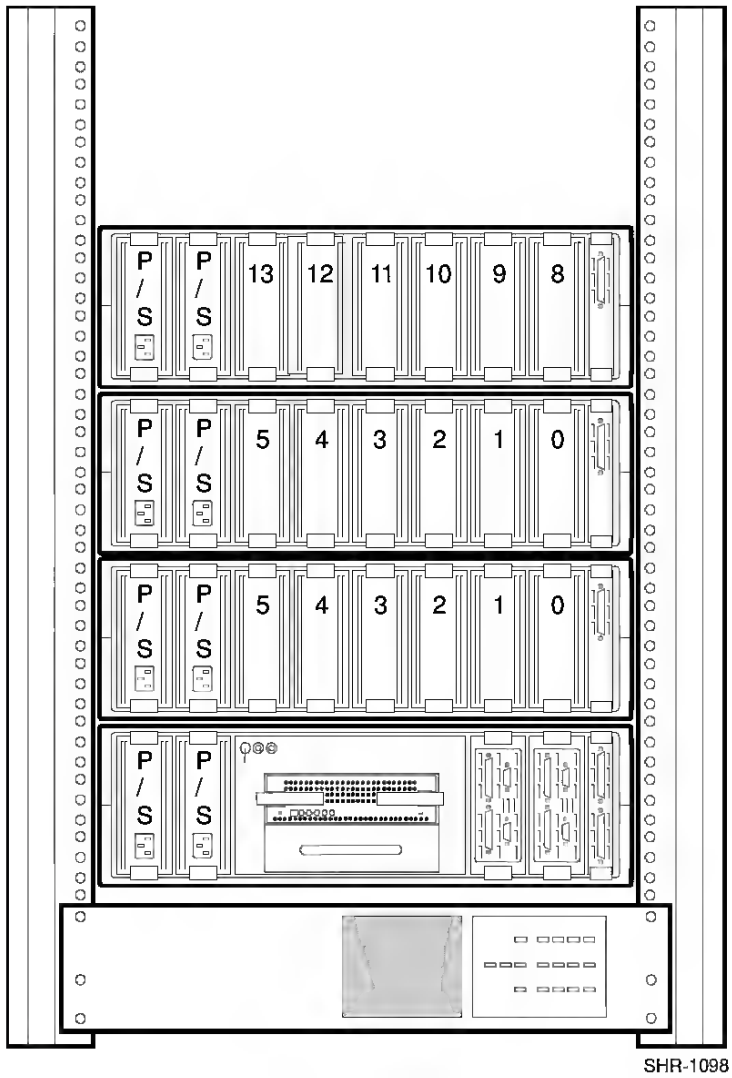

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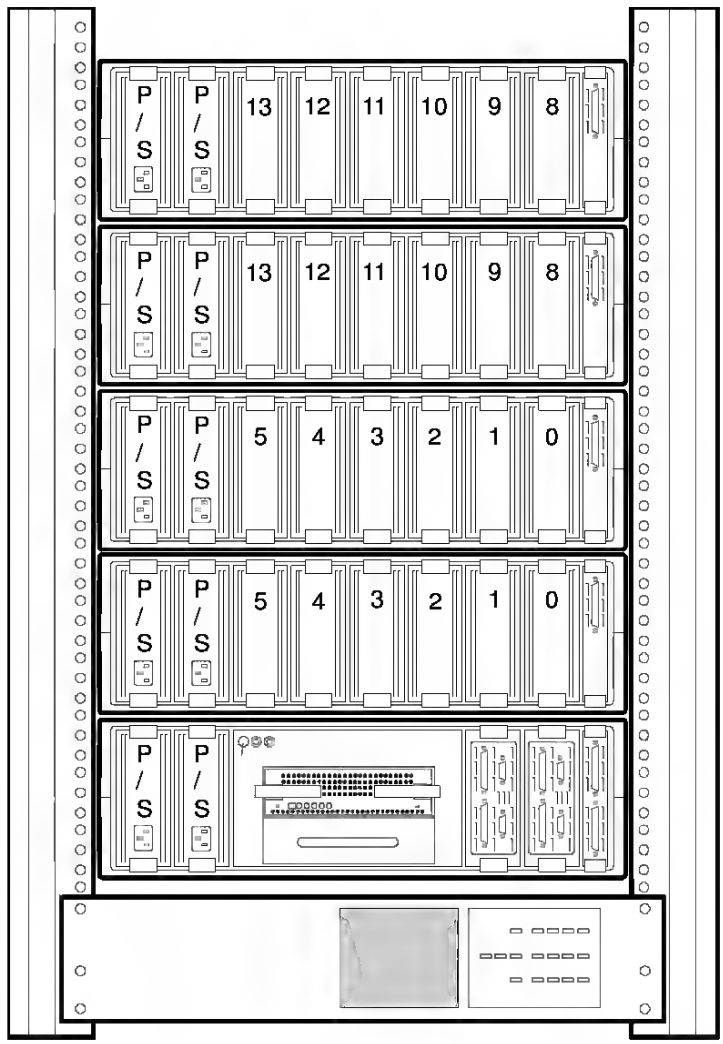
Figure 3–4 Recommended Installation (Four Expansion Shelves)



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3.2.1 Installing Shelf Supports

After you determine the desired shelf slot locations in your cabinet, install the shelf support mounting kits supplied with the shelves. Shelf support mounting kits for the RETMA and metric style cabinets are included with each shelf assembly. The UPS is rack mounted using custom adjustable rail brackets. Table 3–1 lists the shelf support mounting kits and identifies the documents and procedures that contain the instructions needed to install them.

Table 3–1 Shelf Support Mounting Kits and Installation Guides

Cabinet Style	Shelf Support Kit Part No.	Installation Guide/Part No.
RETMA Cabinet Installation (round hole).	70-33381-01	See Section 3.2.1.1.
RETMA Cabinet Installation (square hole).	70-33381-01	See Section 3.2.1.2.
Metric Cabinet Installation	BA35X-RD	*SW500 and SW800 Cabinet Metric Shelf Bracket Kit Installation Guide (EK–35XRD–ID)*
UPS Installation into a RETMA or Metric Cabinet	74-53154-01/02 (plus hardware)	See Section 3.2.2 below.

3.2.1.1 Installing Shelf Supports in a RETMA Cabinet (Round Hole)

Use the following procedure to install the shelf support kit into a RETMA cabinet with round holes in the mounting rails (see Figure 3–5).

1. Open the kit and ensure it contains the items listed in Table 3–2.

Table 3–2 RETMA Cabinet Shelf Support Parts List

Item	Part Number	Description	Qty.
1	74-46419-01	Shelf Retainer Bracket, (0.25 inch)	4
2	74-46419-02	Shelf Retainer Bracket, (1.50 inch)	2
3	74-48220-01	Shelf Support – BA350-SA	1
4	74-48220-02	Shelf Support – BA350-SA	1
5	74-48223-01	Nut Plate	2
6	74-50250-01	Support Bracket – BA350-24/U	1
7	90-00063-37	Screw – 10 x 32	14
8	90-06565-00	Nut – 10 x 32	2

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2. Determine the mounting location in your cabinet.
3. Install the left shelf support by aligning the bracket and cabinet rail holes and then securing the support to the cabinet using two screws (item 7, Figure 3–5). Do not tighten screws.
4. Install the nut plate (item 5, Figure 3–5) behind the left rail and secure with three screws. Tighten all five screws.
5. Repeat steps 2, 3, and 4 to install the right shelf support in the cabinet.
6. Install the support bracket (item 6, Figure 3–5) by securing the bracket studs with two plate nuts (item 8, Figure 3–5).
7. Install a shelf retainer bracket (item 1, Figure 3–5) in the rear slot of the left shelf support and secure with two screws.
8. Repeat step 7 to secure a shelf retainer bracket to the right shelf support.
9. Place the Controller Shelf on the cabinet shelf supports and slide the shelf completely to the rear of the cabinet.
10. Install two shelf retainer brackets (item 1, Figure 3–5) to the left and right rails of the cabinet and secure with two screws. The Controller Shelf is now safely mounted in the cabinet.

3.2.1.2 Installing Shelf Supports in a RETMA Cabinet (Square Hole)

Use the following procedure to install the shelf supports into a RETMA cabinet with square holes in the mounting rails (see Figure 3–5).

1. Open the kit and ensure it contains the items listed in Table 3–2.
2. Retrieve six washers (part no.: 90-06664-00) from general packaging.
3. Determine the position of the shelf supports in the cabinet.
4. Install the left shelf support by aligning the support and cabinet rail holes and then securing the support to the cabinet using three screws (item 7, Figure
   3–5) and washers. Tighten the screws.
5. Repeat steps 3, and 4 to install the right shelf support in the cabinet. Align the support with the left unit and tighten the screws.
6. Install the support bracket (item 6, Figure 3–5) by securing the bracket studs with two plate nuts (item 8, Figure 3–5).
7. Install a shelf retainer bracket (item 1, Figure 3–5) in the rear slot of the left shelf support and secure with two screws.

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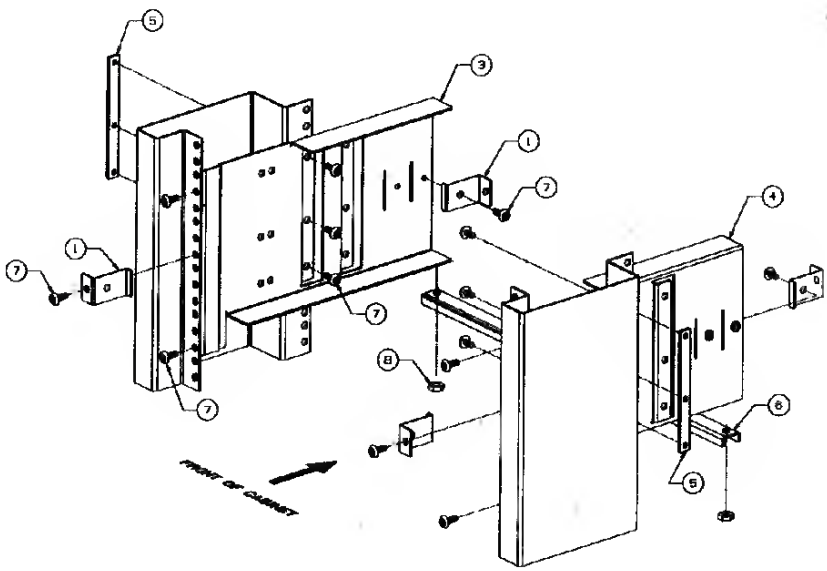
8. Repeat step 7 to secure a shelf retainer bracket to the right shelf support.
9. Place the Controller Shelf on the cabinet shelf supports and slide the shelf completely to the rear of the cabinet.
10. Install two shelf retainer brackets (item 1, Figure 3–5) to the left and right rails of the cabinet and secure with two screws. The Controller Shelf is now safely mounted in the cabinet.

Figure 3–5 RETMA Cabinet Shelf Supports



3.2.2 Installing UPS Brackets

The shelf brackets that support and secure the UPS in the cabinet are a custom design. The following procedure describes how to install the rack-mount brackets. It applies to both cabinet designs – RETMA and metric. You will need the following items to properly install the UPS brackets in your style cabinet:

- 2 UPS rack-mount brackets (74-53154-01 and -02)
- 1 Bag (Table 3–3 lists contents) of mounting hardware (99-06557-05)
- Phillips-head screwdriver

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Table 3–3 UPS Rack-mount Bracket Mounting Hardware List

Cabinet Style	Hardware Item	Part Number
RETMA (round hole)	Screw	90-00063-39
	U-Nut	90-07786-00
RETMA (square hole)	Screw	90-40331-01
	Cage Nut	90-11476-01
	Washer	90-0664-00

Figure 3–6 shows the left and right-hand UPS bracket assemblies. Figures 3–7 and 3–8 illustrate the front and rear bracket mounting holes for both cabinet designs. Refer to these figures throughout the bracket installation procedure.

1. Determine the mounting location in your cabinet (bottom of cabinet recommended for stability).
2. Install U-nuts (or cage nuts depending on cabinet style) corresponding to the "E" holes for RETMA cabinets or "M" holes for metric cabinets (see Figure 3–7).
3. If installing into a RETMA cabinet, align the left-hand bracket "E" holes with the corresponding holes in the cabinet (extend rear of bracket beyond rail for installation), insert two screws, and secure with to cabinet with a cage nut or U-nut.

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Figure 3–6 UPS Rack-mount Bracket Assemblies

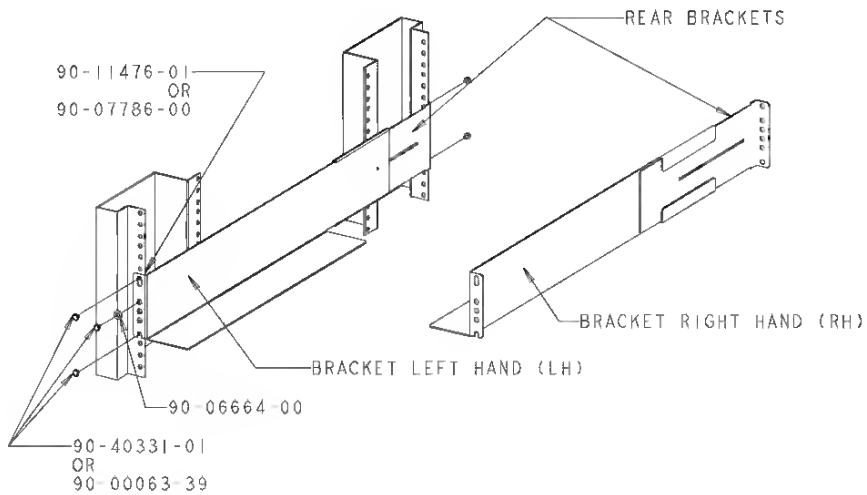
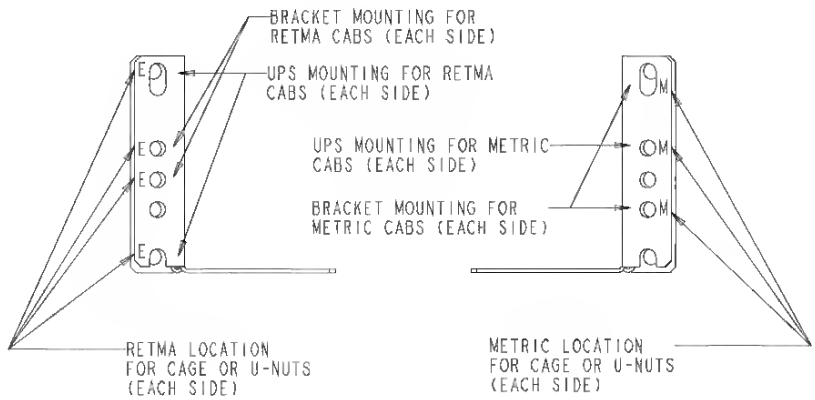


Figure 3–7 UPS Bracket RETMA and Metric Hole Locations (Front)



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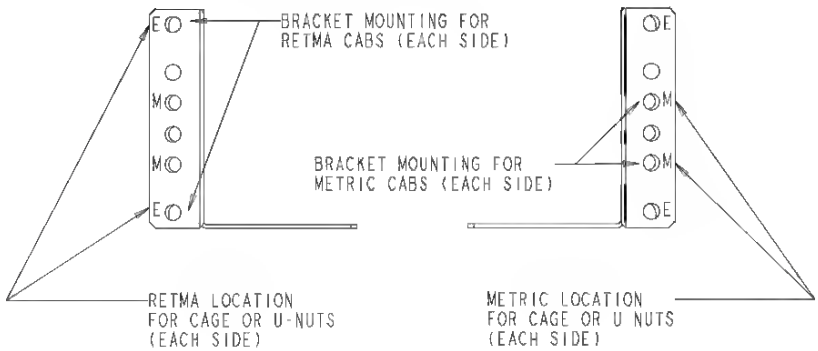
4. Pull and extend the rear bracket assembly until it reaches the hole mounting channel at the rear of the cabinet and install cage nuts (or U-nuts) at the rear of the rail into the corresponding holes in the cabinet (see Figure 3–7). Extend the bracket beyond rail and tighten the hardware to secure the bracket to the cabinet.
5. Install the UPS right-hand bracket on the right side of the cabinet using the same hole patterns and hardware used in steps 2 and 3.
6. Ensure both brackets are level and tighten all hardware.
7. Carefully lift and insert the UPS onto the brackets and push the unit back into the cabinet until the mounting holes in each flange aligns with the corresponding holes in the cabinet.
8. Secure the front panel of the UPS to the cabinet (see Figure 3–8 for correct holes) using two SST flat-washers and screws.
9. Connect the UPS power cord to the ac power strip.

Figure 3–8 UPS Bracket RETMA and Metric Hole Locations (Rear)



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3.3 Power and SCSI Cable Connection Procedures

This section contains the power and SCSI cabling procedures for a single or multiple Device Expansion Shelf subsystem installation. Each procedure describes how to connect the Controller Shelf to the Device Expansion Shelve(s), the host system, the UPS, and the maintenance PC. Your Controller and Device Expansion shelf shipment contains all of the power, serial control, and SCSI data cables required to connect and configure your system. These cables, along with two Trilink adapter connectors allow you to create a single or multiple storage subsystem as shown in Figures 3–1 through 3–4.

The section is divided into four procedures that describe how to connect a single or multiple-shelf configuration. Each is supported by a wiring diagram and is independent of the other three. Proceed to the procedure that applies to the number of Device Expansion Shelves you are connecting to the Controller Shelf.

NOTE

All four cabling procedures describe how to connect your subsystem to a single host via the host I/O module 0 connector on the Controller Shelf. The procedures are the same for host I/O module 1. Also, no connections are shown to the Host *Out* connector on the I/O module. This connector is electrically the same as *Host In* and is used for mid-bus connections in a multiple-host configuration.

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3.3.1 SCSI Bus Target Addresses and Termination

NOTE

The SCSI bus address switch on the Controller Shelf device I/O module has been disabled. It does affect or control the SCSI bus addresses of the devices in the Device Expansion Shelves. The target addresses of the disk drives are set by address switch S3 on the personality module in each Device Expansion Shelf.

The SCSI bus device address and termination switches should be set before connecting the SCSI cables between the Controller and Device Expansion Shelves. The SCSI bus addresses of the devices in each Device Expansion Shelf is set by address switch (S3) on the side of the personality I/O module in each shelf.

The SCSI bus termination on each device bus is set by the SCSI bus termination switch (S4) on the device I/O module of the Controller Shelf and the Personality I/O module on each Device Expansion Shelf.

The correct SCSI bus ID addresses and termination switch settings for single and multiple Device Expansion Shelf installations are shown on the diagrams that support the four following cabling procedures.

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3.3.2 Cabling a Single Device Expansion Shelf Subsystem (See Figures 3–9 and 3–10)

1. Ensure the physical installation phase of installing and securing shelf brackets and shelves (including the UPS) has been accomplished and that the shelves are secured within the shelf bracket the shelf lock provided.
2. Remove the device I/O module from the Controller Shelf and ensure the switch positions of SCSI bus termination switch S4 are set as shown in Figure 3–9. Replace the module in the Controller Shelf.
3. Remove the personality I/O module from the Device Expansion Shelf and set SCSI bus termination switch S4 on this module as shown in Figure 3–9.
4. Ensure SCSI bus address switch S3 on the personality I/O module is set for the device addresses as shown in Figure 3–9. Replace the module in the Device Expansion Shelf.
5. Connect the black ac power cords (supplied with the shelves) from the ac power source to the outside power supply on each shelf (see Figure 3–10).
6. Connect the gray power cables from the inside power supply on each shelf to the power receptacles on the back of the UPS (ensure the UPS is connected to an ac source).
7. Connect a 0.5-meter SCSI cable (BN37A-0E) from the top SCSI connector on the Controller Shelf device I/O module (device bus 1) and the SCSI connector on the front of the personality I/O module on the Expansion Shelf.
8. Connect a 5-meter SCSI cable (BN37A-05) between the *host-in* connector on the Controller Shelf host 0 I/O module (bottom connector) and the corresponding connector on the host system.
9. Connect the maintenance serial control cable (17-04730-01) from the *CTR 0* connector on the Controller Shelf host 0 I/O module to the corresponding connector on the maintenance PC.
10. Connect the UPS serial control cable (17-04729-01) from the *UPS* connector Controller Shelf host 0 I/O module to the like connector on the UPS.
11. Install jumper connector 12-49700-01 to the Controller Shelf UPS connector on the host 1 I/O module.

CAUTION

To prevent possible damage to the equipment, the input voltage level of the UPS must be set to your specific line voltage before proceeding. Refer to the UPS manual and set the input level to your ac power source(s).

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12. After the UPS has been set to the correct input voltage level, set the UPS low-battery warning option to five minutes (refer to UPS manual for instructions).
13. This completes the Controller and Device Expansion Shelf cabling procedure. Dress and ty-wrap related cable groups, and then refer to the *RAID Array 3000 Getting Started and Command Console Installation and User Guides* for information describing how to setup and configure your subsystem.

Figure 3–9 Controller/ Single Device Expansion Shelf Cabling Diagram

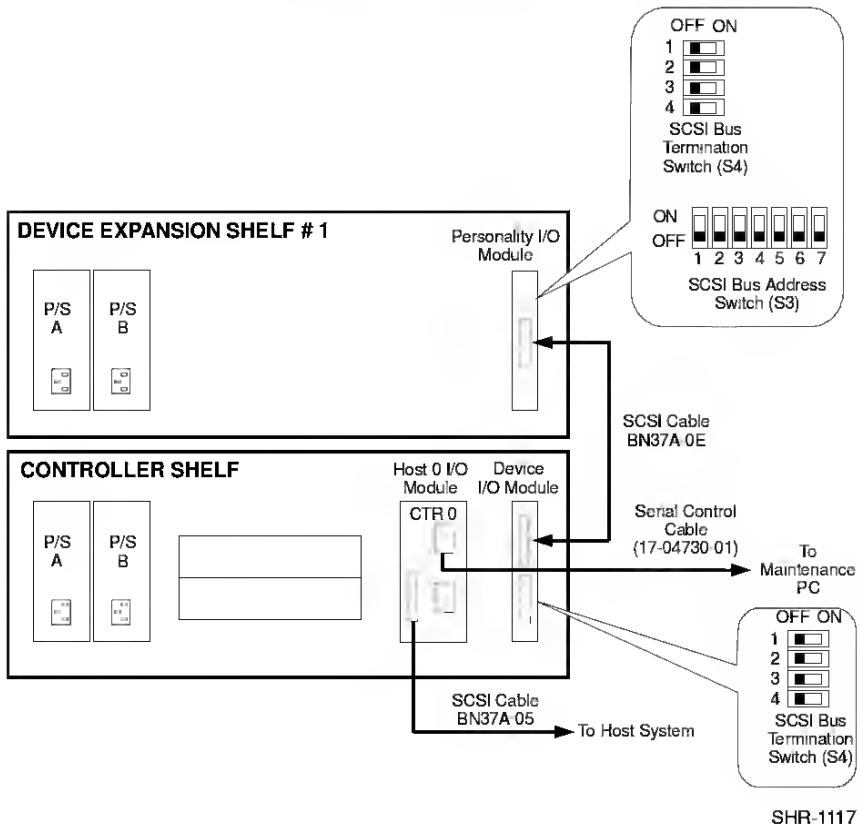

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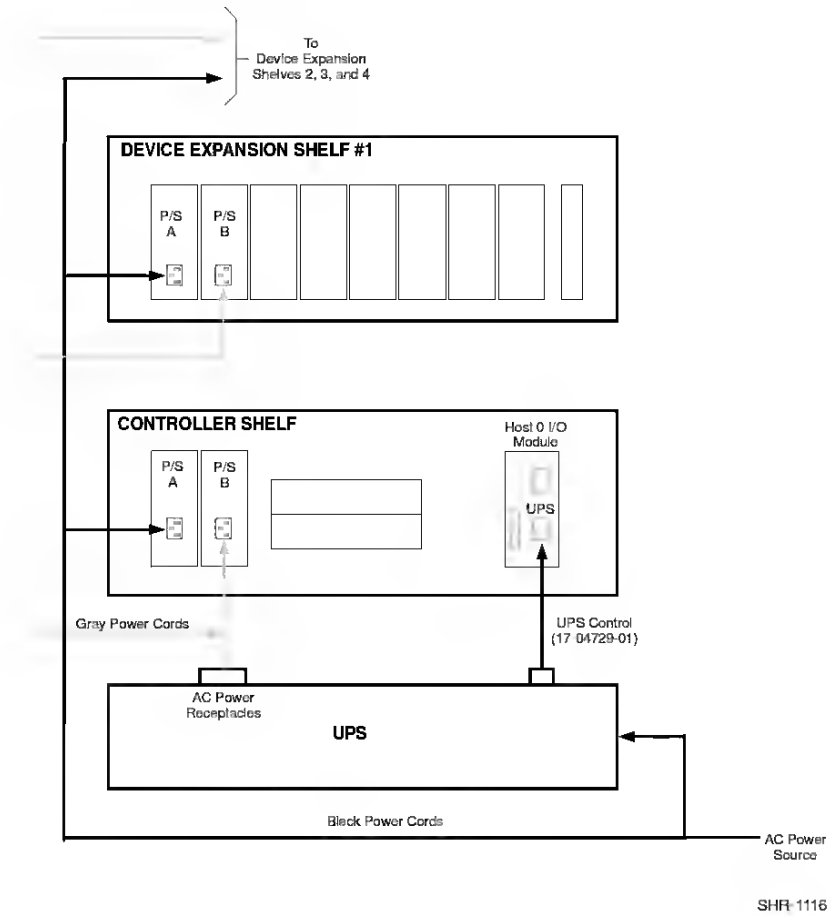
Figure 3–10 AC Power Wiring Diagram



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3.3.3 Cabling a Two Device Expansion Shelf Subsystem (See Figures 3–10 and 3–11)

1. Ensure the physical installation phase of installing and securing shelf brackets and shelves (including the UPS) has been accomplished and that the shelves are secured within the shelf bracket the shelf lock provided.
2. Remove the device I/O module from the Controller Shelf and ensure the switch positions of SCSI bus termination switch S4 are set as shown in Figure 3–9. Replace the module in the Controller Shelf.
3. Remove the personality I/O module from Device Expansion Shelf # 1 and set SCSI bus termination switch S4 and SCSI bus address switch S3 on this module as shown in Figure 3–11.
4. Remove the personality I/O module from Device Expansion Shelf # 2 and repeat step 3.
5. Connect the black ac power cords (supplied with the shelves) from the ac power source to the outside power supply on each shelf (see Figure 3–10).
6. Connect the gray power cables from the inside power supply on each shelf to the power receptacles on the back of the UPS (ensure the UPS is connected to an ac source.
7. Connect a 0.5-meter SCSI cable (BN37A-0E) from the top SCSI connector on the Controller Shelf device I/O module (device bus 1) and the SCSI connector on the front of the personality I/O module on the Expansion Shelf.
8. Connect a second 0.5-meter SCSI cable (BN37A-0E) from the bottom SCSI connector on the Controller Shelf device I/O module (device bus 2) and the SCSI connector on the front of the personality I/O module on the Device Expansion Shelf # 2.
9. Connect a 5-meter SCSI cable (BN37A-05) between the *host-in* connector on the Controller Shelf host 0 I/O module (bottom connector) and the corresponding connector on the host system.
10. Connect the maintenance serial control cable (17-04730-01) from the *CTR 0* connector on the Controller Shelf host 0 I/O module to the corresponding connector on the maintenance PC.
11. Connect the UPS serial control cable (17-04729-01) from the *UPS* connector Controller Shelf host 0 I/O module to the like connector on the UPS.
12. Install jumper connector 12-49700-01 to the Controller Shelf UPS connector on the host 1 I/O module.

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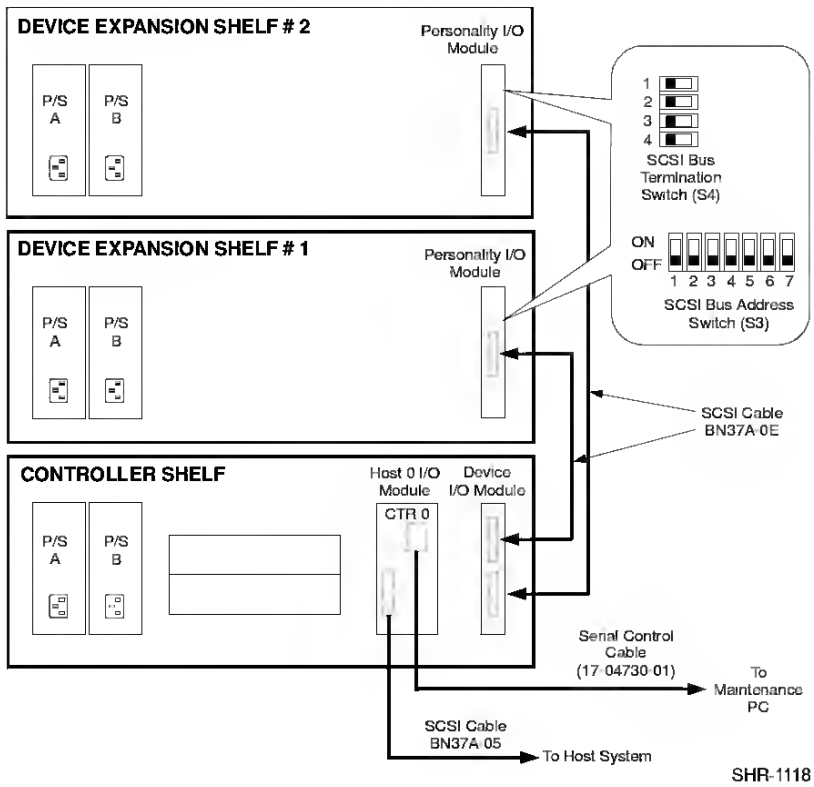
Figure 3–11 Controller/ Two Device Expansion Shelf Cabling Diagram



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CAUTION

To prevent possible damage to the equipment, the input voltage level of the UPS must be set to your specific line voltage before proceeding. Refer to the UPS manual and set the input level to your ac power source(s).

13. After the UPS has been set to the correct voltage level, set the UPS low-battery warning option to five minutes (refer to UPS manual for instructions).
14. This completes the Controller and Device Expansion Shelf cabling procedure. Dress and ty-wrap related cable groups, and then refer to the *RAID Array 3000 Getting Started and Command Console Installation and User Guides* for information describing how to setup and configure your subsystem.

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3.3.4 Cabling a Three Device Expansion Shelf Subsystem (See Figures 3–10 and 3–12)

1. Ensure the physical installation phase of installing and securing shelf brackets and shelves (including the UPS) has been accomplished and that the shelves are secured within the shelf bracket the shelf lock provided.
2. Remove the device I/O module from the Controller Shelf and ensure the switch positions of SCSI bus termination switch S4 are set as shown in Figure 3–9. Replace the module in the Controller Shelf.
3. Remove the personality I/O module from Device Expansion Shelf # 1 and set SCSI bus termination switch S4 and SCSI bus address switch S3 on this module as shown in Figure 3–12.
4. Remove the personality I/O modules from Device Expansion Shelves # 2 and # 3 repeat step 3.
5. Connect the black ac power cords (supplied with the shelves) from the primary ac power source to the outside power supply on each shelf (see Figure 3–10).
6. Connect the gray power cables from the inside power supply on each shelf to the power receptacles on the back of the UPS (ensure the UPS is connected to a secondary ac source.
7. Connect the single-connector end of a Trilink adapter to the SCSI connector on the personality module in Device Expansion Shelf # 1. Tighten the screws on the adapter to ensure it is firmly seated.
8. Connect a 0.5-meter SCSI cable (BN37A-0E) from one connector on the adapter to the top SCSI connector (device bus 1) on the front of the Controller Shelf device I/O module.
9. Connect a second 0.5-meter SCSI cable (BN37A-0E) from the other connector on the adapter to the SCSI connector on the front of the personality I/O module on the Device Expansion Shelf # 3.
10. Connect a third 0.5-meter SCSI cable (BN37A-0E) from the bottom SCSI connector on the Controller Shelf device I/O module (device bus 0) to the SCSI connector on the front of the personality I/O module on the Device Expansion Shelf # 2.
11. Connect a 5-meter SCSI cable (BN37A-05) between the *host-in* connector on the Controller Shelf host 0 I/O module (bottom connector) and the corresponding connector on the host system.
12. Connect the maintenance serial control cable (17-04730-01) from the *CTR 0* connector on the Controller Shelf host 0 I/O module to the corresponding connector on the maintenance PC.

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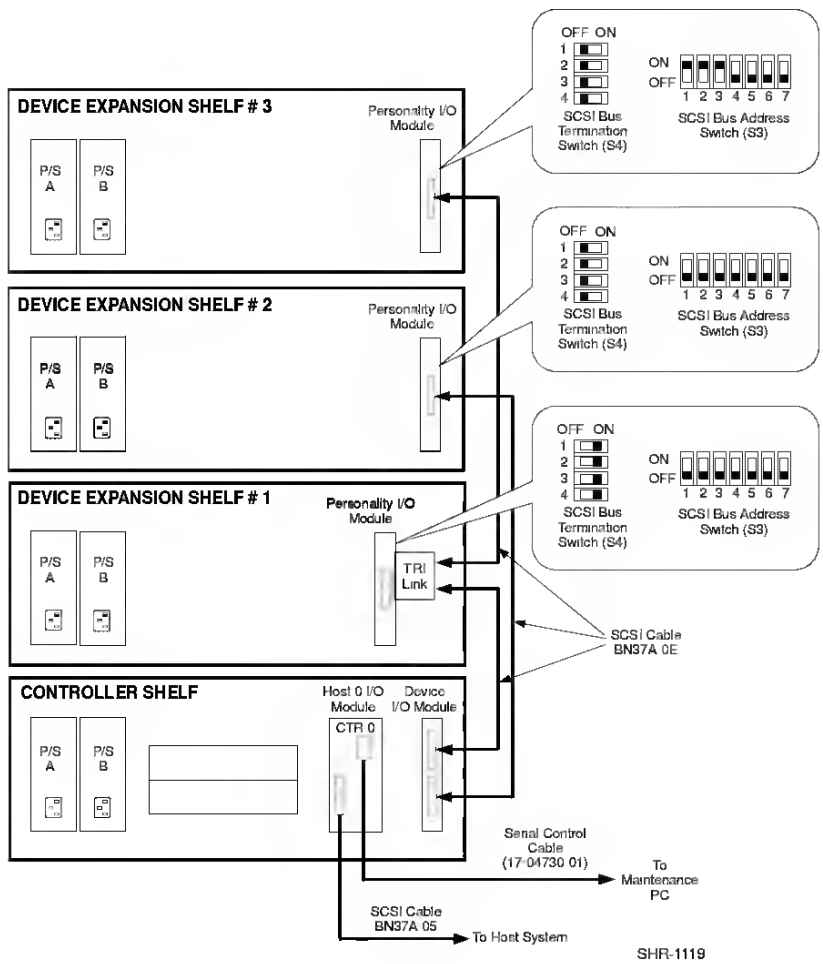
Figure 3–12 Controller/ Three Device Expansion Shelf Cabling Diagram



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13. Connect the UPS serial control cable (17-04729-01) from the *UPS* connector Controller Shelf host 0 I/O module to the like connector on the UPS.
14. Install jumper connector 12-49700-01 to the Controller Shelf UPS connector on the host 1 I/O module.

CAUTION

To prevent possible damage to the equipment, the input voltage level of the UPS must be set to your specific line voltage before proceeding. Refer to the UPS manual and set the input level to your ac power source(s).

15. After the UPS has been set to the correct input voltage level, set the UPS low-battery warning option to five minutes (refer to UPS manual for instructions).
16. This completes the Controller and Device Expansion Shelf cabling procedure. Dress and ty-wrap related cable groups, and then refer to the *RAID Array 3000 Getting Started and Command Console Installation and User Guides* for information describing how to setup and configure your subsystem.

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3.3.5 Cabling a Four Device Expansion Shelf Subsystem (See Figures 3–10 and 3–13)

1. Ensure the physical installation phase of installing and securing shelf brackets and shelves (including the UPS) has been accomplished and that the shelves are secured within the shelf bracket the shelf lock provided.
2. Remove the device I/O module from the Controller Shelf and ensure the switch positions of SCSI bus termination switch S4 are set as shown in Figure 3–9. Replace the module in the Controller Shelf.
3. Remove the personality I/O module from Device Expansion Shelf # 1 and set SCSI bus termination switch S4 and SCSI bus address switch S3 on this module as shown in Figure 3–13.
4. Remove the personality I/O modules from Device Expansion Shelves # 2, # 3, and # 4 and repeat step 3.
5. Connect the black ac power cords (supplied with the shelves) from the primary ac power source to the outside power supply on each shelf (see Figure 3–10).
6. Connect the gray power cables from the inside power supply on each shelf to the power receptacles on the back of the UPS (ensure the UPS is connected to a secondary ac source.
7. Connect the single-connector end of a Trilink adapter to the SCSI connector on the personality module in Device Expansion Shelf # 1. Tighten the screws on the adapter to ensure it is firmly seated.
8. Connect the single-connector end of a second Trilink adapter to the SCSI connector on the personality module in Device Expansion Shelf # 2. Tighten the screws on the adapter to ensure it is firmly seated.
9. Connect a 0.5-meter SCSI cable (BN37A-0E) from one connector on the adapter connected to shelf # 1 to the top SCSI connector (device bus 1) on the front of the Controller Shelf device I/O module.
10. Connect a second 0.5-meter SCSI cable (BN37A-0E) from the other connector on the adapter connected to shelf # 1 to the SCSI connector on the front of the personality I/O module on the Device Expansion Shelf # 3.
11. Connect a third 0.5-meter SCSI cable (BN37A-0E) from the one connector on the adapter connected to shelf # 2 to the bottom SCSI connector (device bus 0) on the front of the Controller Shelf device I/O module.
12. Connect a fourth 0.5-meter SCSI cable (BN37A-0E) from the other connector on the adapter connected to shelf # 2 to the SCSI connector on the front of the personality I/O module on the Device Expansion Shelf # 4.

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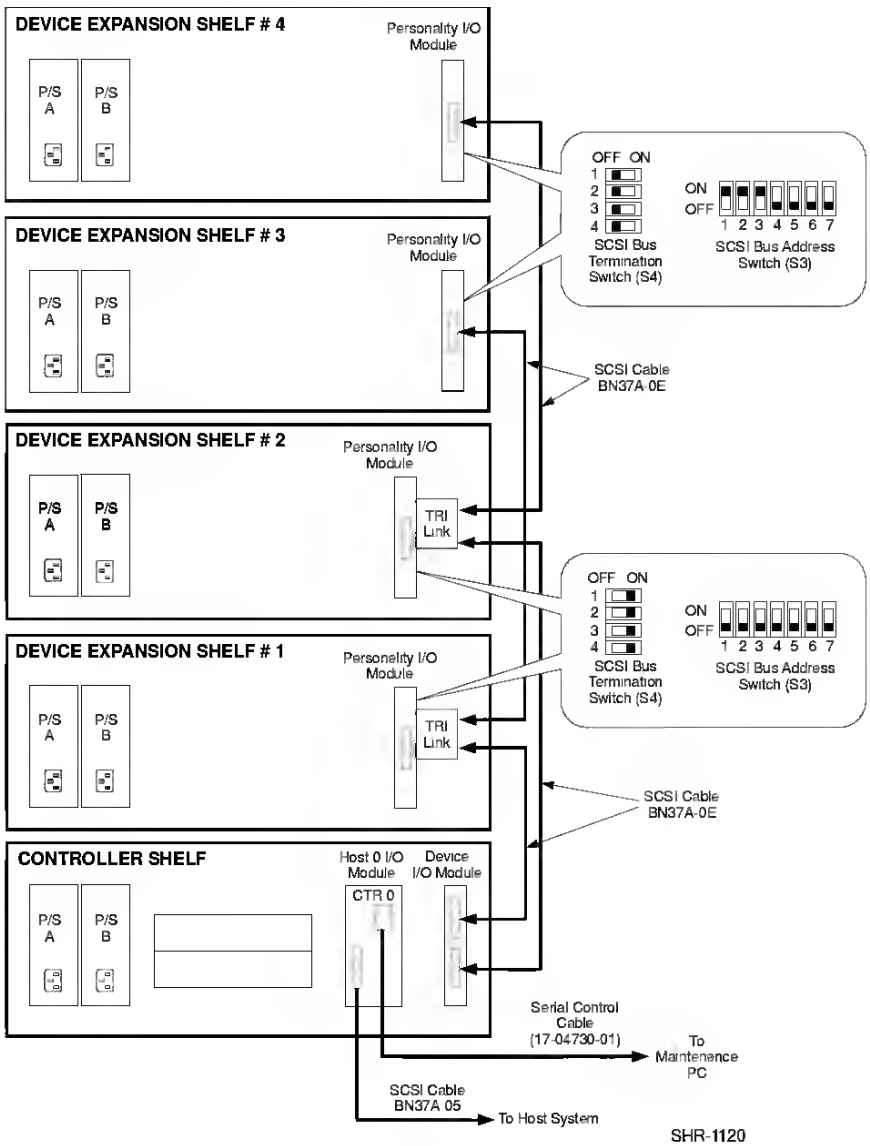
Figure 3–13 Controller/ Four Device Expansion Shelf Cabling Diagram



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13. Connect a 5-meter SCSI cable (BN37A-05) between the *host-in* connector on the Controller Shelf host 0 I/O module (bottom connector) and the corresponding connector on the host system.
14. Connect the maintenance serial control cable (17-04730-01) from the *CTR 0* connector on the Controller Shelf host 0 I/O module to the corresponding connector on the maintenance PC.
15. Connect the UPS serial control cable (17-04729-01) from the *UPS* connector Controller Shelf host 0 I/O module to the like connector on the UPS.
16. Install jumper connector 12-49700-01 to the Controller Shelf UPS connector on the host 1 I/O module.

CAUTION

To prevent possible damage to the equipment, the input voltage level of the UPS must be set to your specific line voltage before proceeding. Refer to the UPS manual and set the input level to your ac power source(s).

17. After the UPS has been set to the correct input voltage level, set the low-battery warning option to five minutes (refer to UPS manual for instructions).
18. This completes the Controller and Device Expansion Shelf cabling procedure. Dress and ty-wrap related cable groups, and then refer to the *RAID Array 3000 Getting Started and Command Console Installation and User Guides* for information describing how to setup and configure your subsystem.

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3.4 Controller Shelf Status LEDs

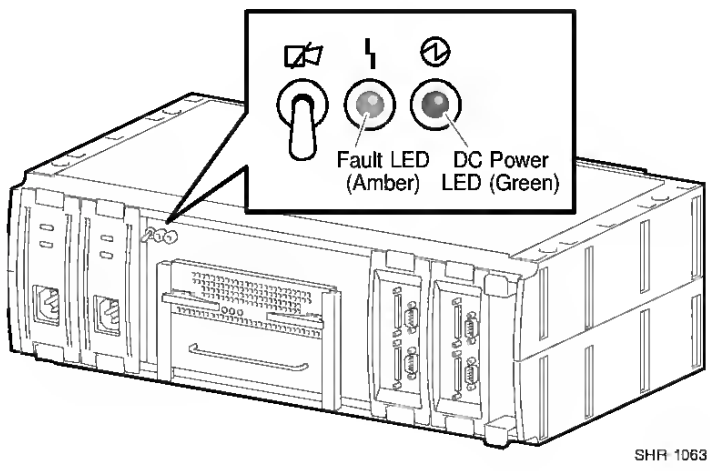
The Controller Shelf is equipped with two front-panel LEDs (see Figure 3–14) that monitor the following error conditions:

- A shelf blower that is not operating
- An over-temperature condition
- A dc power problem
- External fault conditions
- Controller faults

When the shelf is operating properly, the green *power* LED is on and the amber shelf *fault* LED is off. If a dc power problem develops, the power LED goes out indicating a malfunction.

The amber shelf status LED is normally off. If an error condition occurs, the LED comes on and an audible alarm sounds notifying the operator that an error condition exists. Once the user has been notified and is aware of an error, the alarm disable toggle switch enables the operator to disable the audible alarm by using the switch.

Figure 3–14 Shelf Status LEDs



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3.5 Controller LEDs

The LEDs on the front panel of the controller monitor host and disk channel activity and a controller fault condition. The reset button/LED flashes green approximately once every second (heartbeat) to indicate that the controller is operating normally. Figure 2–3, Chapter 2, identifies the LEDs. Table 2–1 describes their functions.

3.6 Replacing Components (FRU's)

This section describes how to replace an FRU in the RAID Array 3000 controller shelf. The information is divided into the following subsections:

- Replacing a Host I/O or Device I/O SBB in the controller shelf
- Replacing a shelf power supply SBB
- Replacing the RAID controller
- Replacing the UPS
- Replacing a blower
- Replacing a controller memory cache module

NOTE

The rack-mount UPS is also field replaceable. Refer to the user's guide supplied with the unit for the order number and instructions of how to replace it.

Figure 3–15 is an exploded view that shows the Field Replaceable Units in the controller shelf. Table 3–4 lists the units and their corresponding part numbers.

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Figure 3–15 Controller Shelf Field Replaceable Units

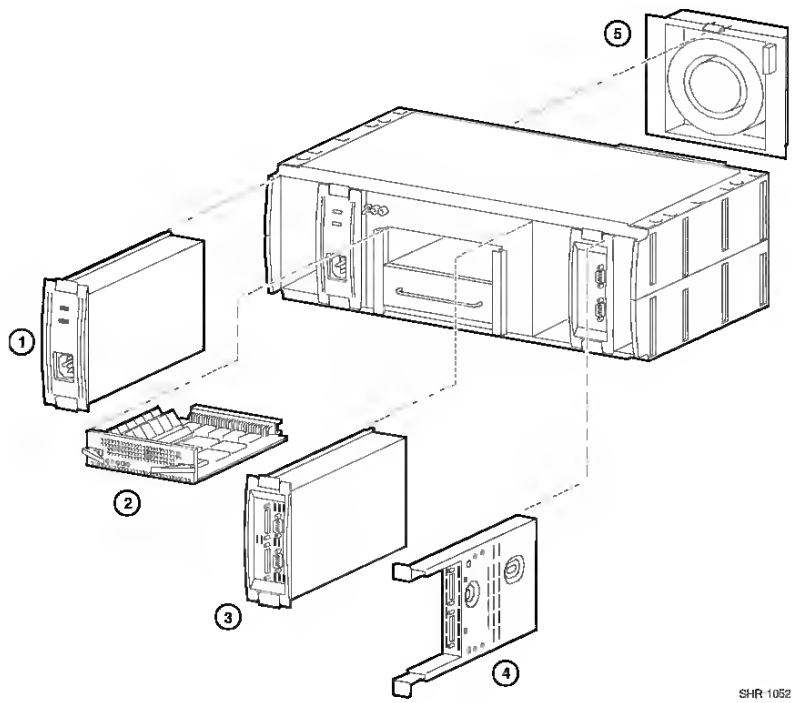

Table 3–4 Controller Shelf Field Replaceable Units

Item	Qty.	Part Number	Description
1	2	30-48191-04	Power Supply, 180 W, 50/60 Hz, +5 V, +12V,
2	1*	70-33523-01	RAID Controller
3	2	70-33525--01	Host I/O Module
4	1	70-33067-05	Device I/O Module
5	2	70-29761-07	Blower Assembly

* Second (redundant) controller is optional

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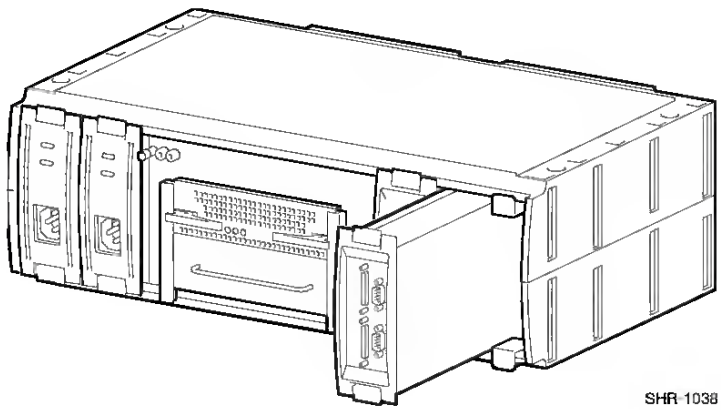
3.6.1 Replacing a Host or Device I/O SBB

CAUTION

When you remove an SBB, the airflow through the shelf is reduced. Always install the replacement unit immediately to prevent overheating.

1. Ensure the SCSI bus connected to the SBB is quiescent (no I/O activity).
2. Disconnect the cables (or jumper) from the front panel of the SBB.
3. Release the SBB from the shelf slot by squeezing the mounting tabs on the SBB together and pulling it forward until clear of the shelf (Figure 3–16).
4. Insert an identical model SBB in the slot and push it in until an audible click is heard indicating the SBB is fully seated (SBB front panel mounting tabs expand and engage the shelf).
5. Observe that the SBB status LEDs are operating.
6. Reconnect the cables and jumper (if installed on the original module).

Figure 3–16 Replacing the Host I/O SBB



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3.6.2 Replacing a Power Supply SBB

CAUTION

When you remove a power supply, the airflow through the shelf is reduced. Always install the replacement unit immediately to prevent overheating.

You can replace a dc power supply without affecting shelf operation using the following procedure:

1. Remove the ac input power cable from the shelf power supply.
2. Squeeze the mounting tabs to release the unit and pull it out of the shelf.
3. Insert the replacement power supply into the shelf slot, align the guide slots, and then push it in until the SBB tabs lock into place.
4. Connect the input power cable to the power supply ac receptacle.
5. Observe the LEDs on the replacement power supply and ensure that the unit is operating properly.
6. If the shelf power is removed during power supply replacement, the controller must place the storage devices on-line sequentially at four-second intervals. Make sure the LEDs on both the power supply and the storage devices indicate normal operation.

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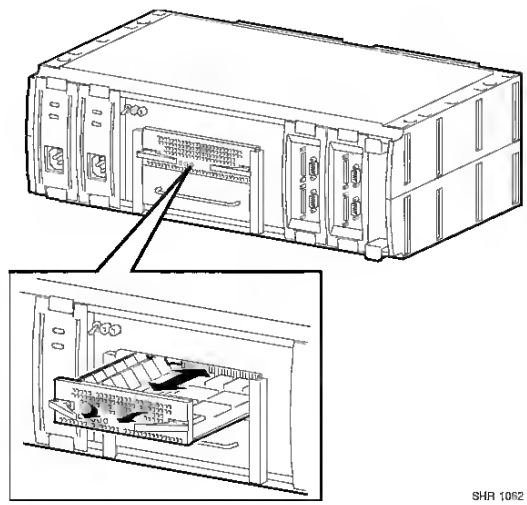
3.6.3 Replacing the RAID Controller

CAUTION

When you remove the controller, the airflow through the shelf is reduced. Always install the replacement unit immediately to prevent overheating.

1. Ensure the SCSI bus connected to the SBB is quiescent (no I/O activity).
2. Grip the two locking latches on the front panel of the controller and pull them forward until the controller disengages from its mounting slot (Figure 3–17).
3. Transfer the SIMM(s) to the new controller.
4. Remove the controller by sliding it forward and free of the shelf.
5. Insert the replacement controller into the open slot, align the module into the card guides, and gently slide it into the shelf until the connector engages the backplane connector in the shelf.
6. Turn the two front panel latches inward to seat the controller in the shelf slot.
7. Restore the configuration using SWCC.

Figure 3–17 Removing the Controller from the Shelf



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3.6.4 Replacing the UPS

Proceed as follows to replace the UPS:

1. Ensure the UPS power switch is set to off.
2. Disconnect the shelf power cords from the rear receptacles on the UPS.
3. Disconnect the UPS power cord from the wall outlet.
4. Disconnect the serial control cable from the controller shelf.
5. Remove the screws that secure the front panel of the UPS to the cabinet.
6. Install the replacement UPS and replace the screws removed in step 5 to secure the unit.
7. Reconnect the power cords and the serial control cable.
8. Set the UPS output voltage level to your specific ac power source.
9. Set the UPS power switch to on, set the UPS low-battery warning option to five minutes (refer to UPS manual), and then power-up the shelf.

3.6.5 Replacing a Blower

WARNING

Only qualified service personnel should access the rear of the shelf to replace a blower.

The controller shelf has two blowers mounted on the rear. Connectors on the backplane provide the +12 Vdc to operate the blowers. When a blower fails, the shelf status (amber) LED on the power supply SBB is OFF and an error message is passed to the controller or host via the shelf status signal. The Device I/O assembly status LEDs indicate which blower has failed and then automatically switches the remaining blower to high speed. Refer to the *SBB I/O Module User's Guide* (Part No.: *EK-SBBIO-UG*) supplied with the device expansion shelf for additional LED and blower status information.

Use one of the following procedures to replace a blower (see Figure 3–18).

CAUTIONS

The blowers are dual-speed devices and should be replaced only with identical units.

Shelf air flow is lost when a blower is removed. Replace immediately or damage can result.

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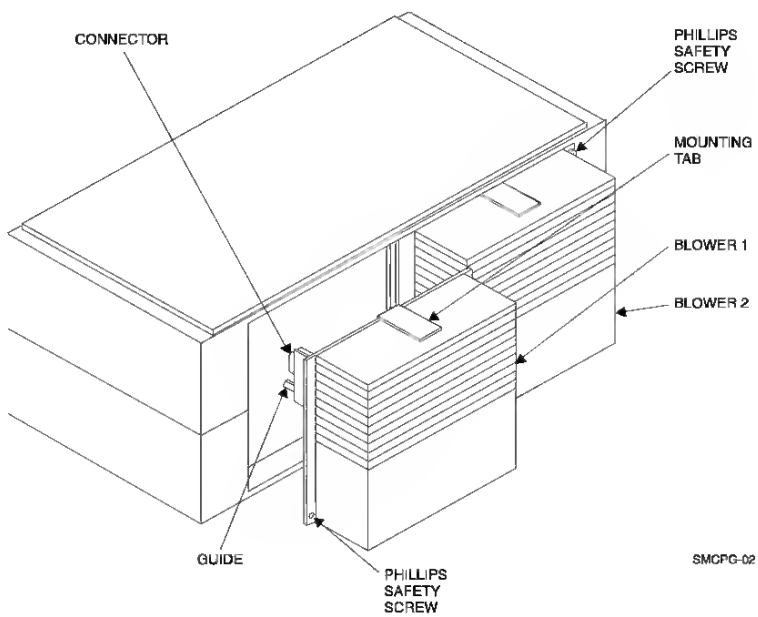
If you *can* access the blowers from the rear of the cabinet, proceed as follows:

1. Use a Phillips-head screwdriver to remove the safety screw in the upper right corner or lower left corner of the blower (see Figure 3–18).
2. Press the upper and lower blower mounting tabs together to release the blower.
3. Pull the blower straight out to disconnect it from the shelf power connector.
4. Align the replacement blower connector and push the blower straight in, making sure that both mounting tabs lock in place.

Figure 3–18 Replacing a Blower Assembly



5. Insert the safety screw.
6. Verify that the shelf and all SBBs are operating properly by observing the LEDs.

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If you *cannot* access the blowers from the rear of the cabinet, proceed as follows:

1. Disconnect the cables from the front of the controller shelf and remove the shelf from the cabinet.
2. Use a Phillips-head screwdriver to remove the safety screw in the upper right corner or lower left corner of the blower.
3. Press the upper and lower blower mounting tabs together to release the blower.
4. Pull the blower straight out to disconnect it from the shelf power connector.
5. Align the replacement blower connector and push the blower straight in, making sure that both mounting tabs lock in place.
6. Insert the Phillips safety screw.
7. Reinstall the shelf and reconnect the cables.
8. Verify that the shelf and all SBBs are operating properly by observing the LEDs.

NOTE

If the blower status LEDs on the Device I/O assembly are not off and all shelf power supplies are operating, the second blower could have failed or the wrong blower was replaced.

3.6.6 Replacing the Controller Memory Cache Modules

The memory cache modules in the RAID controller (see Figure 3–19) are replaced by removing the controller from the shelf to gain access to the modules. Then, place the controller on a flat working surface and proceed as follows:

CAUTION

To prevent an electrical discharge from damaging the SIMMs, always wear an ESD wrist strap connected to a suitable ground when handling the memory chips.

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1. Power down the controller shelf first (via SWCC) and then the UPS.
2. Grasp the latches on the front of the controller and pull them forward until the controller disengages from the shelf (see Figure 3–17).
3. Remove the controller from the shelf and place on a flat working surface.
4. Remove the two installed cache memory SIMM modules by releasing the locking clips at each end of the module until it disengages and snaps into an upright position as shown in Figures 3–20 and 3–21.

Figure 3–19 Controller Cache Modules

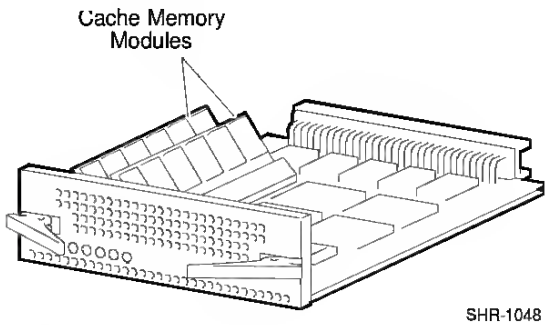

Figure 3–20 Release Locking Clips

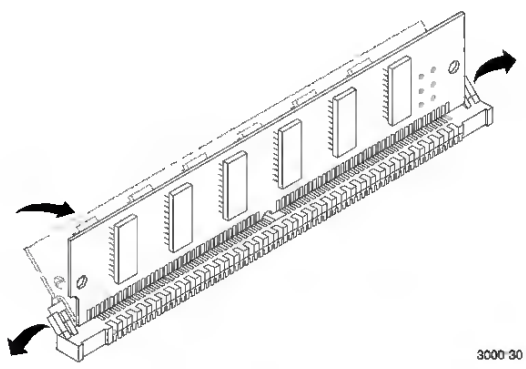

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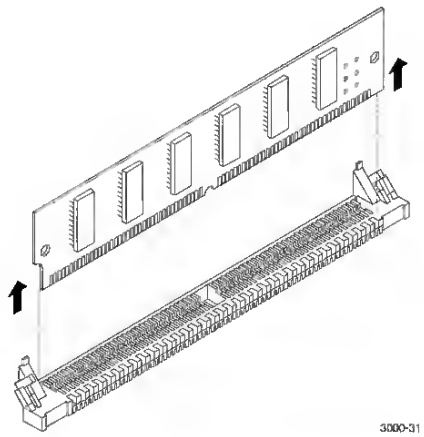
Figure 3–21 Remove Installed SIMM Modules



CAUTION

Ensure the "side 1" side of the two replacement SIMMs is facing toward you when installing the modules in the following step.

5. Installed the two replacement memory modules by aligning the module and connector pins (check alignment guide in center of module) and gently pivot the module the main controller board until it snaps into place (see Figures 3–18 and 3–19).
6. Replace the controller into the shelf.
7. Power on the UPS and shelf and check the activity LEDs on the front panel of the controller. The reset switch/LED should begin to flash at a half-second rate (heartbeat) and the host activity LEDs should flash.

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Figure 3–22 Install Replacement Modules

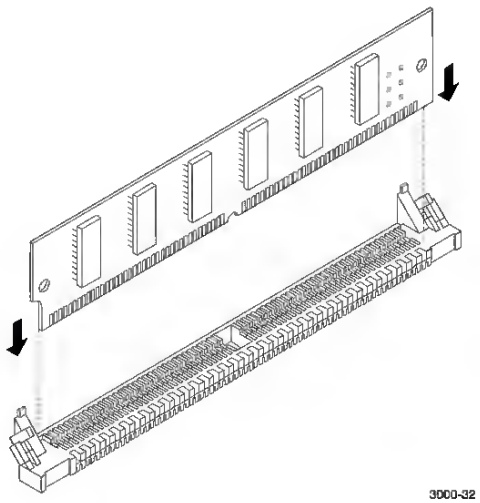
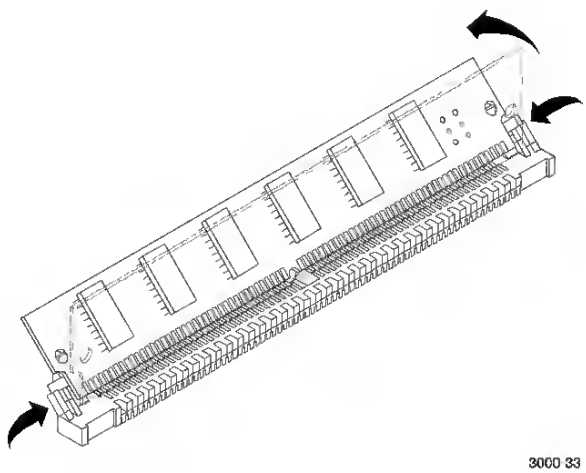


Figure 3–23 Pivot Module Down to Secure



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4

Second Controller Option

This chapter describes how to install a second RAID controller in the RAID Array 3000 Controller Shelf. The second controller option adds a fail/safe feature to your storage subsystem. The chapter also contains a procedure describing how to configure the subsystem for dual-controller operation when only one serial port is available on the host.

4.1 Introduction

The controller option adds a second (redundant) controller unit to your subsystem to preserve the integrity of data should the first controller malfunction. The second controller is installed directly below the existing controller in the bottom controller slot of the RAID Array 3000 controller shelf.

The installation procedure consists of adding two SIMM memory modules to the redundant controller and, depending on the option kit you are installing (see inventory below), one or two SIMM modules to the existing controller. Following the memory upgrade, you must upgrade the firmware in both controllers , seat the devices in their respective controller slots and configure the subsystem to accommodate a redundant controller.

Perform an inventory of the items contained in the second controller kit option. The kit should contain the following:

RAID Array 3000 Controller

For option kit DS-HSZ22-AA, 3 SIMMs

For option kits DS-HSZ22-AB, 4 SIMMs

CD with new Firmware

Model Label

Warranty Card

This Guide

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4.2 Installing the Upgrade

CAUTION

To prevent an electrical discharge from damaging the SIMMs, always wear an ESD wrist or foot strap connected to a suitable ground when handling the memory modules.

NOTE

You can upgrade your firmware using the SCSI or network connection methods. These methods provide the fastest way to upgrade your firmware. To update your controller's firmware, proceed as follows.

4.2.1 Save Existing Configuration

NOTE

You must save the subsystem configuration using the StorageWorks Command Console Client (SWCC) before performing the installation procedure. Otherwise, the RAID controller may lose your configuration.

To save your current configuration:

Select the **Storage** pull-down menu from the Toolbar (see Figure 4-1), click on **Controller,** select **Configuration**, and then **Save**.

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Figure 4-1. Saving the Existing Configuration

A saved configuration screen with a "Save to File" field appears as shown in Figure 4-2. The example in Figure 4-2 shows the file name as `c:\config1`.

Enter your file name in the "Save to File" field and click on **Save.**

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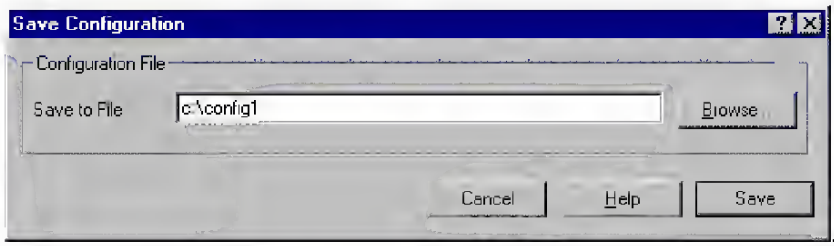
Figure 4-2. Saved Configuration



4.2.2 Update Firmware

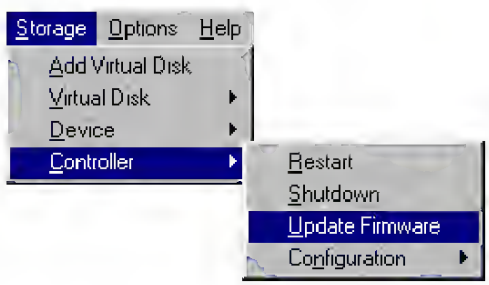
CAUTION

If the systems disk is on the RA3000, firmware cannot be upgraded with SWCC. Establish a temporary system disk on a disk drive outside the RA3000 and proceed with these instructions or follow the alternative shown in Section 4.2.2.2.

4.2.2.1 Update Firmware Using SWCC

Start SWCC and choose **SCSI** or **Network Connection**. From the **Storage** menu (see Figure 4-3), select **Controller**, and then select **Update Firmware**.

Figure 4-3 Update Firmware Command



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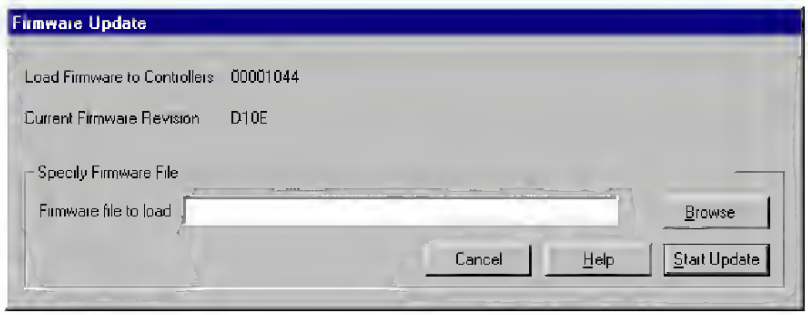
A window will appear (see Figure 4-4) asking you to specify the firmware file that you want to load. This file resides on the CD supplied with the controller kit option. You can easily identify Firmware software by its `.fdi` extension. Enter the `.fdi` file name (for example, D:\firmware\xxx.fdi), then click **Start Update**. Upon completion of the Firmware update, the system will automatically reboot and update the controller's firmware.

Figure 4-4. Firmware Update Dialog Box



4.2.2.2 Update Firmware Using Serial Interface

NOTE

Follow this procedure only when the host operating system is installed on the RA3000.

1. Properly shutdown your host system
2. Using either a laptop computer or a computer other than that attached to the RA3000, connect a serial cable between the COM port on that machine and the corresponding serial port (CTR1 or CTR2) for the controller on the RA3000.
3. Start a terminal emulator session. On Windows NT, we suggest the Hyper-Terminal emulator. Settings to be used are 9600 baud, 8 bits, No Parity, 1 stop bit, XON/XOFF.
4. To get the controller's attention, press Escape/& (escape key, shift key, number 7). The controller should respond with a banner stating DEC HSZ22 DEC Monitor Utility, followed by the firmware revision number. You will not actually be using this utility to upgrade the firmware, but knowing that it is operational makes the next step easier.

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5. Reset the controller by power cycling the RA3000 subsystem. You should see a "**Flash Boot Utility...** " banner, followed by instructions to type CTRL/C to abort. Press CTRL/C to abort the load sequence. A "**FLASH Boot Utility Options**" menu should be displayed.
6. Choose menu item (2), Change serial baud rate. Select 38400. When presented with the "Please change your baud rate and press RETURN" message, do so from within HyperTerminal via the **File\Properties** menu, then choose '**Configure...** If there is no response from the utility after changing the baud rate, proceed with Step 6.
7. After changing the baud rate, you may have to close and re-enter HyperTerminal. Press the RETURN key after HyperTerminal restarts. You should see **the FLASH Boot Utility Option** menu again.
8. Select menu item "**1) Download new Firmware Image**". Using the Transfer menu in HyperTerminal, choose **Send Text File** and send the firmware. You should see a "**Receiving code for System Version <ver>"** message, followed by a series of \ | / - characters cycling at the end of the line. At 9600 baud, the download will take between 45-60 minutes. At 38400, it should take around 10-12 minutes. At completion, you'll see the **FLASH Programming complete** message, followed by the **FLASH Boot Utility Options** menu again.
9. Select item 9, **Restart Controller**. You'll be instructed to reset the baud rate back to 9600, which you'll again do from the HyperTerminal **File \Properties \Configure**... menu. As before, you'll probably have to exit and restart HyperTerminal to get any response. Press Enter when Hyperterminal restarts.
10. Your firmware should now be upgraded.

4.2.3 Shutdown RA3000

1. Ensure that both host ports are in a quiescent state (no I/O activity).
2. Shut down the Host System.
3. Issue a "shutdown" command from the SWCC Console to the controller shelf.
4. Power **OFF** the controller shelf.

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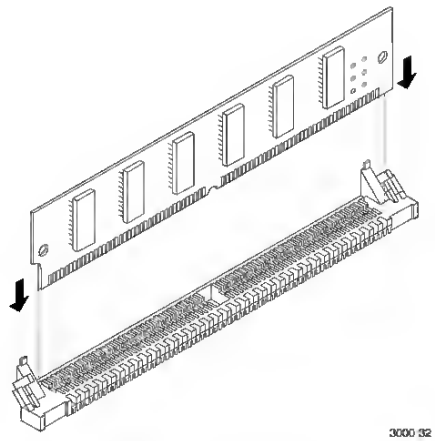
4.2.4 Install Two SIMMs into Second Controller

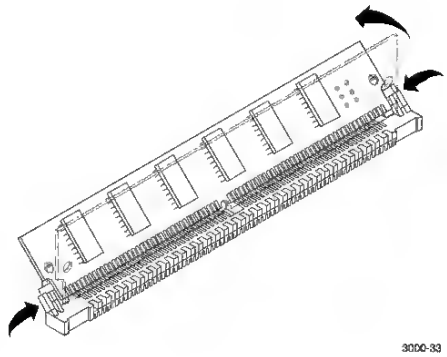
1. Install two of the SIMM modules into the second controller (make sure all SIMM modules are of the same type) by aligning the connector pins and inserting the modules into the SIMM module connectors as shown in Figure 4-5.

Figure 4-5. Insert Module into SIMM Connector



2. Ensure the module is firmly seated and then gently pivot it toward the controller board until it snaps into place as shown in Figure 4-6.

Figure 4-6. Pivot Module Down to Seat



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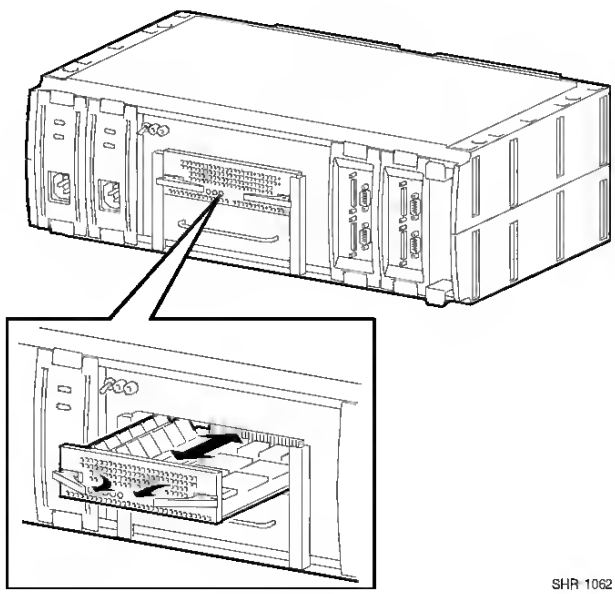
4.2.5 Replace Existing Controller

1. Replace the existing controller (see Figure 4-7 to remove) with the new controller.

Figure 4-7. Remove Controller from Top Slot



NOTE

Ensure you install the new controller in the same slot as the existing controller removed in step 1 above. Do not leave the existing controller in the controller shelf while performing the following step.

2. Power up the system and proceed to the following section to restore the configuration on the new controller.

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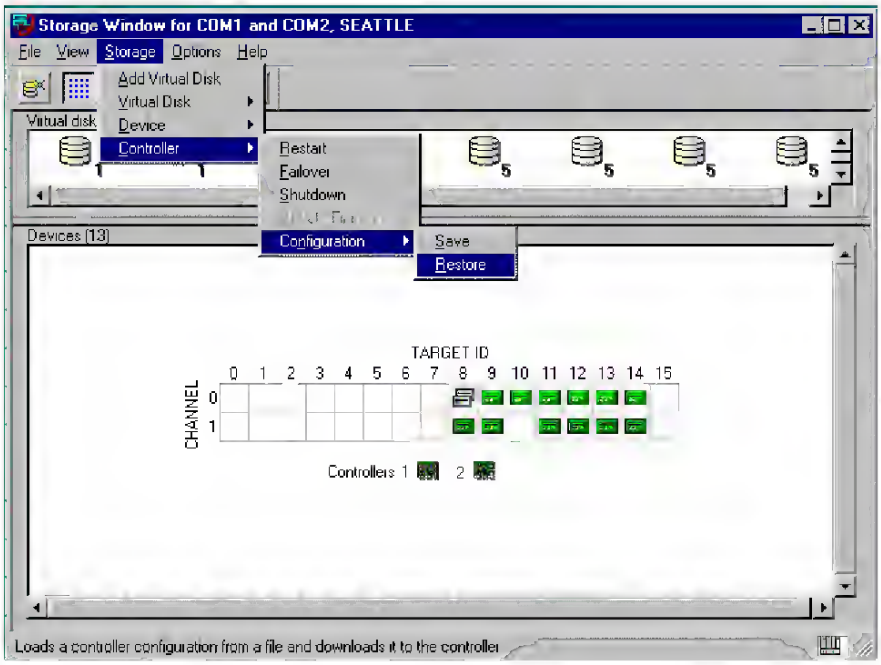
4.2.6 Restore Configuration

To restore your configuration to the new controller:

1. Restart SWCC in the "Serial Mode" (refer to your *RA3000 Getting Started Guide* for instructions).
2. Select the **Storage** pull-down menu from the Toolbar, then choose **Controller**.
3. From the **Controller** pull-down menu (Figure 4-8), select **Configuration**, and then **Restore**.

Figure 4-8. Restoring Configuration to New Controller



The saved configuration screen with a "Restore from File" field appears as shown in the example of Figure 4-9.

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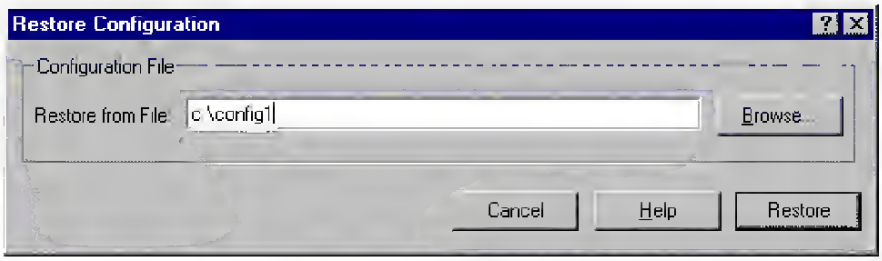
Figure 4-9. Restored Configuration Example



NOTE

Restoring the configuration in the following step may take up to 5 minutes. Be patient.

4. Enter the file name that you saved in Section 4.2.1 and click on **Restore**.

4.2.7 Update Firmware on Second Controller

1. After configuration has been restored, update firmware on the second controller. Repeat the procedure in Section 4.2.2.1 or 4.2.2.2.
2. After the configuration has been restored and firmware has been updated, power down the system.

4.2.8 Install Original Controller

1. If installing option kit DS-HSZ22-AA, add the second SIMM to the original controller. If installing option kit DS-HSZ22-AB, replace the existing SIMM with the two remaining SIMMs supplied with the kit. (See Section 4.2.4 for instructions.)
2. Install the second controller into the controller shelf and power up the system. The system is now in the dual-redundant operating mode.
3. Locate the second serial cable that came in the second controller kit. Connect this cable to the second controller serial port on the RA3000 and to COM 2 port and restart SWCC in serial mode. You now have two serial connections.
4. To check that the controller pair is in redundant mode, click on the **Controller** icon. Properties for both controllers should be visible. Firmware revision of both controllers must be identical. If either controller is shown in gray, refer to your *RA3000 Getting Started Guide* for more detailed instructions.

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4.3 Configuring a Dual Controller Installation for a Single Serial Port

This section describes how to configure your RA3000 storage system for dual controller operation when only one serial port is available on the host. If required, refer to your Getting Started guide for SWCC installation instructions. The information in this section is divided as follows:

- Configuring the RA3000 Storage System for dual-controller operation
- Connecting to your dual controller storage system using a serial connection
- Verifying the Controller Operating Parameters

4.3.1 Configuring the RA3000 for the Active Mode of Operation

If you are upgrading from a single controller storage system, the installed controller will be in the active/passive mode of operation. To configure the storage system using a single serial connection, the dual controllers must be placed in active/active mode. Perform the procedure to change your storage system from "active/passive" to "active/active" mode of operation.

1. Shutdown the RA3000 storage system, install the second controller, and restart the system.
2. Connect the host serial port to the serial port connector on the top controller of the RA3000.
3. Open an HSZ22 monitor utility terminal session. The terminal settings should be: 9600 BAUD, 8 bits, no parity, 1 stop bit, XON/XOFF. If prompted for a password, enter "RAID".
4. When the terminal session is displayed, press "ESCAPE/&" (key sequence: Esc, Shift, 7). The controller should respond with banner listing *HSZ22 Monitor Utility* followed by the Firmware revision number.
5. Select *Setup Parameters* from the main menu.
6. Select *Rdnt Ctrlr Parameters* and change the value of Host I/O Channel 1 to *Passive*. Press Ctrl-Z to exit.
7. Transfer the serial cable to the serial port on the bottom controller and press "Ctrl -Z". When the Monitor Utility screen is displayed, press any key to continue.
8. Select *Setup Parameters* and then select *Rdnt Ctrlr Parameters* from the main menu.
9. Both channels should be displayed as "Passive". Select the host I/O channel that was **not** reconfigured in step 5 and change its value *Active*.
   Press CTRL-Z to exit.

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10. Restart the controllers by power cycling the RA3000 storage system.
11. Recheck the *Rdnt Ctrlr Parameters.* The controller *Values* should display *Active/Passive*.
12. Transfer the serial cable to the serial port on the top controller on the RA3000 and press Ctrl-Z.
13. Check the *Rdnt Ctrlr Parameters.* The controller *Values* should display *Passive/Active*.

Your storage system is now properly configured for dual controller operation from a single serial host port. Proceed to the next section to configure the controllers.

4.3.2 Configuring the Dual Controllers

In order to create a virtual disk, a serial connection must be made to the controller. The serial connection provides a local connection to the RA3000 (HSZ22) controller. To configure the controller, perform the following steps:

1. Ensure the RA3000 Storage System is turned off.
2. Connect the serial cable between the host serial connector and the top controller's serial port connector.
3. Power on the RA3000 storage system.
4. Open the StorageWorks management utility.
5. Select the *Serial* button in the HSZ22 Management window.
6. Select the serial port available on the host's workstation and then click on the *Connect* button.
7. When the second connection window appears, select *Cancel*. Once the connection is established, a storage window will appear with the connected port identified at the top of the window.
8. From the Storage menu, select *Add Virtual Disk*. Select *JBOD* from the menu (you may select any RAID level you wish) and then select *Next*.
9. Select *drive* from the window *Devices Available to Create a New Virtual Disk* and then select Next.
10. Select *Add* and then select *Next*.
11. A window is displayed prompting for selection of the host port that the "JBOD" should be created on. There is a single connection to the controller so only one host port will be available. Select *Next*.
12. Choose a LUN number and enable the write-back cache.
13. Select *Next* and then *Finish*.

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14. You have now created one Virtual Device (JBOD) on the top controller. Disconnect the serial cable from the top controller and reconnect the cable to serial port connector on the bottom (redundant) controller.
15. Close and reopen the StorageWorks window and repeat steps 4 through 13 above (Note: If the storage window connection is lost when the cable is moved, reopen the HSZ22 *StorageWindow*).
16. Once the second "Virtual Disk" has been created, close the StorageWorks window.
17. To complete dual-controller configuration, perform the following.
    - Ensure all cables and connections to your server are in place
    - Leave the RA3000 Rack Mount Storage System powered on
    - Reboot the server

Refer to your *Getting Started Guide* to configure the virtual disks as communications LUNs.

4.3.3 Connecting to Your Dual Controller Storage System

1. Open the StorageWorks management utility.
2. Refer to the *Getting Started Guide* for instructions describing how to connect the RA3000 to your host system.

4.3.4 Verifying the Controller Operating Parameters

For optimal dual- controller performance and load balancing, the host ports should be configured as listed below. Verify these parameters from the "Controller Properties" page:

- Host I/O channel 0 for Controller 1 (top) to Active
- Host I/O channel 1 for Controller 1 to Passive
- Channel 0 Target ID for Controller 1 to 0
- Channel 1 Target ID for Controller 2 to 1

NOTE

It is allowable to configure the host I/O and target IDs as follows:

Controller 1 (top) may be set to "Passive" while host I/O channel 1 for Controller 1 is set to "Active". As long as each host channel value and channel target ID value is unique, the system is correctly configured for Active/Active mode.

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1. Select the "Environment" tab from the *Controller Properties* window.
2. Ensure the cabinet and UPS settings are set to 'normal'.
3. Select the *Cache* tab from the "Controller Properties" window. The SIMMs parameters must be identical between controllers.
4. Select *OK*. The system is now ready for dual-controller operation. Configuration of additional RAIDsets may now be performed as desired.

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